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QUALIFICATIONS OF A RESEARCH PHYSICIST[1]

By Dr. ALBERT W. HULL

GENERAL ELECTRIC COMPANY

I AM going to show you, later, that the figure of merit of a research physicist is expressible in degrees of ignorance rather than knowledge. My first application of this theorem is the willingness, or temerity, to address you upon this subject, about which you know so much more than I.

Please note the narrowness of the subject. Research physicists are a small class—perhaps too small to be called a class. They are a part of the so-called creative group, which is rated at the top of the human ladder by certain students of society such as Dr. Charles R. Gow[2]; and by certain others as akin to the mentally unbalanced. Whether high or low doesn't concern us here. I am merely leading up to the first qualification of a research physicist, which is that he must be born that way.

The aptitudes with which a man is born determine, often uniquely, his field of successful activity. By field is meant, not a specified profession, but some one of a group of related activities which utilize the same qualifications. The most common classification recognizes three types of native ability: the research type, the engineering type, and the executive type. Sometimes the research and engineering types are classed together and a teaching type differentiated. For example, President Hadley[3] summed up these qualifications for Yale undergraduates as follows:

> Speaking broadly, men may be divided into three types or temperaments: the scientific type, consisting of men whose power lies in observing and arranging and put-

[1] Address presented before the American Association of Physics Teachers, Bureau of Standards, April 30, 1931.

[2] Charles R. Gow, "Foundations for Human Engineering," Macmillan, 1930.

[3] A. T. Hadley, "Choosing a Career," *Yale Alumni Weekly*, March 3, 1916.

ting facts in order; the literary type, whose interest lies in communicating ideas to others, and in thus influencing the opinions and actions of their fellow men, and the practical type, which is interested neither in the arrangement of facts nor in the communication of ideas, except as a means of achieving concrete results in the way of business or politics or some form of human endeavor. From the first type come our physicians, our engineers, our accountants, and our consulting experts of every kind. From the second type come our teachers, our preachers, our journalists, and our jury lawyers; from the third, our merchants, our manufacturers, our railroad men, and our consulting lawyers.

It is preferable, I think, to differentiate the research and engineering types, since both the temperament and the training required for these two fields are fundamentally different, as will be shown later.

The point to be observed is that each profession utilizes certain inherent powers. If a man is endowed with these powers in a high degree he can be highly successful; if in small degree, his success in this profession will probably be small, in proportion to his low starting-point.

O'Connor,[4] who has applied the methods of research physics to the personnel problem, has devised some excellent tests for mechanical aptitudes, and has used them to measure the effect of training upon these aptitudes. He finds that repetition of a given operation increases the speed with which both good and bad operators perform this operation to about the same extent, so that their relative standing remains unchanged; but that this practice does not increase the ability of either to perform a similar but slightly different operation.

For example, two girls, who originally required 12 and 6 minutes respectively to pick up 300 pegs, improved with practice until, at the 30th trial, their times were 8 and 4 minutes, respectively. The ratio remained 2 to 1. Twenty girls were selected and divided at random into two groups. After an initial test, which showed the same average time for each group, one group was given two weeks training in a different task, similar to the first except that tweezers were used instead of fingers. Upon repeating the original test the two groups were found to be still equal. Similar tests extending over a period of years instead of weeks led to the same conclusion. Considering the variety in the work of a physicist, these examples teach that the clumsy manipulator will probably remain so through life.

A second test, which is applicable to physicists, is designed to measure the power of space-visualization. It consists in the assembly of a dissected block. Two college room-mates, graduates of a technical school, required 30 sec. and 30 min. respectively to perform this test. Upon repetition the first maintained his 30 sec. record, but could not improve it, being limited by the time required for manipulation; while the second gradually improved until, after 20 repetitions, he equalled the first. The two were then given another block, identical with the first except that it was half as large. The first man assembled it in 30 sec., the other required 20 min. The difference between these two men is not in manipulative skill, for both were equally fast when they knew what to do; but in space sense, one of the prime requirements of a research physicist.

I would like to emphasize still further the importance of these native aptitudes and the degree to which they are unchanged by training.

A prominent executive has rated his engineers, some two thousand in number, according to their performance in their particular fields, designating each by a number. That is, a first-class man in any field would be rated 100, etc. Independent ratings were made by three different observers from different departments, and these were compared with the relative standing of the men in the company, as evidenced by their salaries. In only 2 per cent. of the cases were the differences between these four ratings as great as 5 per cent. Moreover, when these relative ratings were compared with the previous standing of the same engineers over a period of years, it was found that they had changed very little.

These results are significant. They indicate that the chances of a man's success in a given field are determined by qualifications that are fundamental and not easily changed. Whether these inherent traits are hereditary or are acquired early in life is immaterial for the present purpose. In either case, they are firmly fixed by the time the young man presents himself at the college gates.

I have recently had occasion to observe the work of two individuals, one a college graduate and the other a boy of 13, whose space-visualization is so vivid that they connect up the most complicated networks with extreme rapidity and close the switch with confidence. I have never known either to make a mistake. Contrast the future outlook of these men, in the field of experimental research, with that of another, who, in spite of an excellent college and teaching record, charming personality and earnest effort, always had at least one wrong connection, and after two years' trial was pronounced a failure at research work. It was observed that this man was a good contact-maker, and, fortunately, a position was found for him where he could utilize this quality, with his general scientific training as a background. He is now extremely successful and happy.

[4] J. O'Connor, "Born That Way," Williams and Wilkins, Baltimore, 1928.

Not only must the research man have the necessary aptitudes, but he must have no extra ones. O'Connor has called attention to this fact also, and has given many examples which show that unused aptitudes produce dissatisfaction and half-heartedness. For example, a man who makes social contacts easily and enjoys doing so is not likely to be content with the quiet life of a research worker. O'Connor concludes,[5] "The larger the number of gifts, the greater the ultimate goal gained, but, all too often, because of the uneasiness engendered by unemployed aptitudes, the gifted man, wasting year after year, ultimately ends as a failure." You all know such men.

The research worker should therefore be endowed with a retiring personality, in addition to mechanical aptitude or power of space-visualization, analytical ability, and, preferably but not necessarily, manual dexterity. To these we may add the health qualities, energy and enthusiasm, without which all success is circumscribed.

These considerations affect vitally the question of the training of physicists. We can not inculcate or cultivate appreciably the aptitudes that make a physicist possible. We can only add to them certain attitudes and habits and a small store of facts. Without the inborn aptitudes, our trained physicist is like an over-rigged ship, destined to flounder. But what harm? Will not the ship, taught by experience, repudiate its rigging and become eventually a useful and succesful barge? The answer of experience is that in most cases it will not. The unsuccessful graduate seeks still more training in the hope of compensating his handicaps, and so builds ever higher the barrier preventing his escape. The emphasis placed upon science during the last ten years has led some to think that it is better to be a poor physicist than a good mechanic. Such belief leads to tragedy. The good mechanic is a happy, self-respecting, indispensable member of industrial society; the man who feels that he is unsuccessful, be it in science or any other field, is destined to a life of dissatisfaction and unhappiness, and of questionable usefulness. The heart-aches of these men are at your doors, if you have given them the training that thus unfitted them for life.

I have emphasized this question of aptitudes because I believe it is the first duty of every teacher to test and advise those who come to him for training. Satisfactory tests are not at present available, but can be discovered by the same methods which are unraveling spectra and nuclei, the methods of research physics. A beginning is being made, notably at Columbia, Iowa and Ohio State universities. One of the most hopeful signs is the growing custom among graduate schools of canvassing the universities for men with graduate qualifications, and canvassing by industries for men with engineering, accounting and salesmanship qualifications. These canvassers choose wrongly about as often as rightly to-day, because of the lack of proper tests. We can do no greater service to our young men than to assist the development and use of these tests.

Assuming that we have chosen our men, what can we teach them? Not very much, if we accept the opinion of some 1,500 engineers to whom Dr. C. R. Mann, of the Carnegie Foundation, addressed the question: "What are the essential qualities of a successful engineer?" The replies showed an average estimate of:

41 per cent. character
17.5 per cent. judgment
14.5 per cent. efficiency
14 per cent. understanding of human nature
13 per cent. technical knowledge

Assuming that the student's advancement in character, judgment, efficiency and understanding of human nature is no more rapid in college than it would be elsewhere, this means that college training, if perfectly successful, can supply only 13 per cent. of the qualities which an engineer needs, according to the judgment of his peers.

The requirements of a research man are different from those of an engineer. In particular, knowledge is of even smaller relative value. I have no questionnaire to quote you. Instead, I will quote the opinion of one of the greatest research leaders, Dr. W. R. Whitney: "The asset of engineering is exact knowledge. The valuable attributes of research men are conscious ignorance and active curiosity."

In these words he characterized the difference between research and engineering for a group of engineers.[6] It reads like a chemical formula. "The asset of engineering is exact knowledge. The valuable attributes of research men are conscious ignorance and active curiosity."

Do you accept this analysis? It is to be assumed that these qualities are in addition to innate aptitude and the undefinable group known as character, and that the list is purposely incomplete. For the present purpose it is sufficient to agree that conscious ignorance and active curiosity are *among* the most valuable attributes of a research man, and that exact knowledge is not among them.

If you agree, then I would like to ask the question: Are we teaching or can we teach these qualities? We have schools reputed so learned that you can

[5] J. O'Connor, *loc. cit.*, p. 204.

[6] W. R. Whitney, "Stimulation of Research in Pure Science." SCIENCE, 65: 285–9, 1927.

always tell their graduates, but can't tell them much. Have we any that teach conscious ignorance?

The value of this attribute may not at first sight be apparent. Apart from the fact that the know-it-all graduate is unbearable to others, is unwilling to stoop to the task for which he is fitted, and is largely immune to further learning, there is a very special significance to research workers of this attitude of conscious ignorance. *If you know the answer beforehand you will always find that your experiments yield that answer.* You are all familiar with examples of this type, some glaring and obvious, hence comparatively harmless, others difficult to detect, stumbling blocks of science. Our journals are full of theses of students who conclude, quite without evidence, that their professor's theory was correct. Such professors are guilty, in some degree at least, of scientific homicide. Unwittingly, but just as surely, they are killing the scientific honesty of their students. Two glaring cases of such self-deception have come to my attention recently, neither of which is as yet known to the scientific world, and perhaps never will be, but will remain as stumbling blocks. What will become of the authors?

Conscious ignorance is a negative quality and becomes dynamic only when joined to active curiosity. Dr. Whitney is fond of the story of the land turtle, whose curiosity led him to leave the water in search of wider experience, and as a result he not only lives better, but has developed a brain, whereas the water turtle has only the rudiments of a brain.[7] It may be more than a myth that the elephant who couldn't restrain his curiosity and wears an elongated nose in token of it developed into one of our most intelligent animals, while the ichthyosaurus is extinct.

Active curiosity looks for the facts behind the formulas. Ask the average physicist why water rises in a small tube and he may answer, "Because of capillarity." The average chemist will probably tell you that the reason iron doesn't dissolve in strong nitric acid is because of its passivity. Has he added any information in substituting his long word for your short one? If our curiosity is of the kind that is satisfied by a name, it will not lead us far.

I think we may agree that active curiosity, curiosity that not only craves to know and is unsatisfied by names or authority, but does something about it, is one of the most valuable attributes of a research man. Dr. Whitney puts it first. He says[8]: "The most important function of colleges and universities is appreciating inquisitiveness and stimulating research."

If we thus agree, we may analyze our methods of teaching from this view-point, and we need not be surprised if we find that they are unsuited. Our educational system has grown up around the basic idea that knowledge is the magic key to life. As the field of education expanded we have continued to apply the same principle and the same methods. It would be surprising if, in this expansion, we did not find some fields where other objectives and other methods were more important, or arrive at a time when knowledge is a sufficiently common commodity to be within the reach of all who know how to value it. In this case the attitude, the will to find out, becomes the key.

Let us consider the question of lectures from the standpoint of training a research physicist. Is the best lecturer one who explains so lucidly that you are left with a comfortable feeling of understanding, or one who, out of the fullness of his experience, opens out before you the unattainable yet challenging expanse of the subject?

I must leave the answer to you with one suggestive example. Several years ago I listened to a lecture by Sir William Bragg on a subject about which I knew nothing. During the discussion I inquired if he had found a relation between crystal structure and magnetism, and he replied with his charming simplicity, "No, we haven't been able to get the crystal structure of iron. We have some measurements but we can't make much out of them." The next year found me deep in x-ray crystal structure research, trying to find the structure of iron.

With this same objective in mind, of teaching attitudes rather than facts, what is your opinion of textbooks as compared with original sources, or of assigned reading as compared with assigned subjects, or of assigned subjects as compared with assigned problems or experiments?

It is said of the great Agassiz that his invariable practice was to give his students as a first assignment a specimen of something, a fish or a flower, and leave them for three days with absolutely no instructions except to observe.[9]

I have been asked to comment on the kind of training desired for industrial research. For many reasons, I should prefer to follow the advice of President Jewett,[10] to discuss only the qualities desired, leaving to those better qualified the question of matter and methods. I will, however, transmit without comment two suggestions received, the first representing the opinion of three engineering executives, that "training in fundamentals is more useful than in specific subjects"; the second from a prominent

[7] C. J. Herrick, "Brains of Rats and Men," Chicago University Press.

[8] W. R. Whitney, "Stimulation of Research in Pure Science." SCIENCE, 65: 285–9, 1927.

[9] Charles R. Gow, *loc. cit.*, p. 118.

[10] F. B. Jewett, "Modern Business Looks at Secondary Education." *School and Society*, 31: 415–19, 1930.

director of research, who makes the following comments:

> Graduates in electrical and mechanical engineering are generally more adaptable than physicists to the problems of industrial research and development relating to physics. They more readily adapt themselves to the handling of apparatus and equipment and are usually more successful in the use of their hands. They have in general a better physical insight and a greater appreciation of practical requirements for carrying through a developmental program.
>
> It probably does not make a great deal of difference what specialized type of training is received by a certain few men with a natural inclination to industrial problems.
>
> We do feel however that too little stress has of late been placed upon the fundamental physics by most American universities, especially in graduate work. The universities are producing physicists who apparently are well qualified to publish worth while researches in spectroscopy and atomic structure, but who have had almost no training in basic mechanics, hydrodynamics, electrical theory and thermodynamics, such as was taught thirty years ago. We believe that in an industrial laboratory, the physicist or engineer who has the fundamental classical background is of greater value than a physicist who has almost exclusively specialized in the modern physical developments.

The qualities that are desirable for successful life are many. Some must be inborn; others, such as attitudes, habits, skills and facts, may be taught. Each combination of qualities fits a man for certain activities.

The qualifications of a research physicist, as I have pictured them, consist mainly of aptitudes and attitudes. The essential aptitudes are, first, a space-sense that will enable him to devise tests, and, second, a retiring personality that gets pleasure from quiet accomplishment, without the need of public applause. The attitudes are, first, an open mind, more anxious to learn the truth than to show its knowledge, which I have called conscious ignorance; and, second, active curiosity, intent on finding out, nerved to spurn delights and live laborious days for the thrill of discovery at the journey's end. President Jewett, of the Bell Laboratories, calls this the spirit of romance. "The thrill," he says, "of adventuring forth intellectually into the unknown and of charting out there paths which others can follow, is equal to that of him who looks on a new land for the first time; and the number of such journeys that can be taken is limitless."[11]

Consciousness of ignorance, combined with active curiosity, is the spirit of youth. Beware of the man who tells you, "I did that 20 years ago." He is old. He is through, either as investigator or as useful teacher.

If knowledge and experience, culminating in judgment, are incompatible with conscious ignorance, then we are better research men without judgment. I believe they are not incompatible. Conscious ignorance and active curiosity are attitudes which may be caught like contagions, cultivated like choice flowers, and retained to old age. We may be young in attitude, though old in experience. To the spirit of youth each observation is a romance, a revelation. This is the spirit of research.

It is in this spirit that we may hope to see the vision of a still greater science. In the words of Dr. Whitney:

> We ought to realize that there may be a more valuable use of knowledge and truth than commercial developments, and by aiming at the full appreciation of creation we may do more than simply conquer and control our local environment. Perhaps industrial uses of new knowledge are after all only by-products or ways of advancing to something better.
>
> We advance more often by finding in Nature that which we may learn to use than by making or forcing from Nature that which we think we want.

THE PROGRESS OF ROENTGENOLOGY AND ITS CONTRIBUTION TO MEDICAL SCIENCE[1]

By the late Dr. PRESTON M. HICKEY

DR. G. W. C. KAYE prefaces his recent monograph with this passage from Hamlet:

> Come, come, and sit you down; you shall not budge;
> You go not till I set you up a glass
> Where you may see the inmost part of you.
> (*Act III, Sc. 4*).

Little did Shakespeare's world realize that in Hamlet's comment to his mother lay the story of a present-day miracle.

[1] Read before Section N, the American Association for the Advancement of Science, January 1, 1930, by Carleton Barnhart Peirce, A.B., M.S., M.D., of the University of Nebraska College of Medicine.

"I regret most sincerely that illness prevents my former preceptor, Dr. Preston M. Hickey, from reading the paper to you. I appreciate more than words can express the honor of presenting for him the initiatory paper of the American Roentgen Ray Society upon its affiliation with the American Association for the Advancement of Science."

[11] "Research and the Individual," *Bull. of Purdue Univ.* 26, July, 1926.

The observations of William Conrad Roentgen, professor of physics at Wurzburg, crystallized in large measure the preparatory researches of Hittorf, von Helmholtz, Hertz, Lenard, Crookes, and their colleagues in the study of electrical discharges through partially exhausted gas tubes.

This paper, signalizing the recent admission of the American Roentgen Ray Society to affiliation with the American Association for the Advancement of Science, comes at the close of thirty-four years since the discovery of a hitherto unrecognized form of energy by Dr. Roentgen on November 8, 1895.

There appeared in SCIENCE for January 24, 1896, the following news note[2]:

> The *Vienna Presse,* the *London Standard* and other daily papers report what purports to be an extraordinary discovery by Professor Röntgen. It is claimed that he has found that the ultra-violet rays from a Crookes' vacuum tube penetrated wood and other organic substances, whereas metals, bones, etc. are opaque to them. It is said that he has thus photographed the bones in the living body, which would be one of the most important advances that has ever been made in surgery. The photographs have been sent to Vienna and are in the hands of Professor Bolzmann, who has, it is said, accepted the discovery, though he has not succeeded in his attempt to repeat the experiment. In spite of apparently absurd statements concerning the action of the ultra-violet rays it is not impossible that substance such as metals which are good conductors of heat should absorb the ultra-violet rays, while substances such as wood, which are bad conductors of heat, should transmit them. Professor Röntgen is professor of physics at Wurzburg, and any experiments published by him should be accepted without hesitation.

The announcement was followed by much discussion and occasional bitter argument among physicists and investigators the world over. Among the Americans were notably Michael Pupin, Henry W. Cattell, Edwin B. Frost, Thomas Edison, Arthur W. Wright, Arthur W. Goodspeed, Ogden Rood, and William J. Morton. Some fifteen articles in SCIENCE during the first six months of 1896 were devoted to the x-rays. In addition during the same period, the lay magazines, such as *McClure's,* published extensive stories of this new adjunct of science. As occasionally befalls to-day, this development in the field of pure science obtained earlier and, at first, more notice in the lay press than in the scientific.

You are aware, of course, of the vast development and enlargement of the sphere of roentgenology since then. You also are undoubtedly aware of its varied employment to-day in the physical field with the development of crystallography and its allied phases.

[2] SCIENCE, New Series III, No. 56, January 24, 1896, p. 131.

More recently, the Roentgen rays have come to be used in the fields of industry and the arts; for instance, in testing fine machines for flaws in metal parts, the consistency of alloys, fine gems in the lapidaries' hands, and the detection of spurious old masters among oil paintings.

But from its inception the major field has been that of the medical sciences. Dr. Roentgen included in his original communication in the *Sitzungsberichte der Wurzburger Physik medizinische Gesellschaft* a note on the observation of the bones of the hand through the flesh. And yet many physicians of that immediate period expressed grave doubt of its usefulness.

The present occasion we consider as a recognition of the importance of roentgenology as a scientific aid in the study, diagnosis and treatment of disease in the human animal. The medical student, who employs the aid of light and sound in the study and treatment of disease, has always paid a tremendous tribute to the importance of the microscope and the stethoscope. These aids, in turn, perhaps unfortunately we venture to say, are beginning to be surpassed by the important applications of the Roentgen ray.

The development of this special adjunct has in large measure been along two lines; one, the refinement of apparatus and technique for the purpose of better differentiation of the nicer gradations in tissue density, and the control of dosage; the other, in the interpretation of the skiagraphic or Roentgengraphic images obtained. In the former we have had the cooperation of the physicist and engineer, and are well launched on a study of biological effect with the collaboration of the biophysicist. In the latter, we must keep closely associated with the fundamental medical sciences of anatomy, physiology and pathology, especially. Perchance we may be able to link more closely morphology and function, under normal and abnormal conditions, than has been accomplished under the current tendency toward compartmentalization of knowledge and "education."

The close relation to anatomy needs little elaboration. One must have primarily the fundamental structure of embryology and anatomy, both microscopic and gross. We are all aware of a certain shock to our freshman ideas of the placement of the stomach as gained from the cadaver, when we observe under the screen an elongated "fish-hook." This is often the occasion for the exclamation of the novice, "Oh! Oh! J-type!"—a sudden realization that "live" anatomy—or a functioning anatomical structure—is not exactly that of the cadaver and has a wide normal variant. In some laboratories, Roentgen studies are being used more and more to afford the student a sense of regional and functional anatomy, which he

can not procure from his cadaver. This should include both a study of skiagrams of the parts under dissection and fluoroscopic demonstrations of the thorax and gastro-intestinal tract to small groups by a Roentgenologist.

One hesitates perhaps to urge more of this in the purely anatomical laboratories. The physiologist may feel perhaps that all functional observations should be within his department. We wonder if the majority of our colleagues attempting the instruction of students would not welcome an opportunity to assist the anatomist and the physiologist in demonstrating to the student that anatomical parts are related to each other, and that muscles not only contract on stimulation but move other parts in the process. Furthermore, our information of the growth of the individual, his ossification and subsequent decalcification with age has been increased definitely with the Roentgengram.

Here we must of necessity indicate the relatively inseparable juncture with pathology—pathologic physiology, if you will. For the Roentgenscope and skiagram can offer in large measure the clairvoyance of the necropsy without loss of life of the subject. This clairvoyance is somewhat prognostic—but is essentially valuable in the determination of the past insults of disease heaped on the individual human. One might cite pulmonary damage as a facile example.

Diseases of the respiratory tract, both acute and chronic, may be considered particularly amenable to x-ray examination. The gross tissues of the lung are rendered especially suitable for Roentgen studies because they usually include a graphic background of air. The resultant contrasting shadows emphasized by this background of air demonstrate the density of the gross tissues as well as their relative contour. The x-rays thus bring out the subtractions from, and additions to, pulmonary densities which we have learned differentiate the fine degrees of normal and abnormal tissues. A most important characteristic of this examination is that while the microscope requires a microtome and very thin sections of tissue, the x-ray employs optical sections, leaving the patient intact.

The study of the lungs by means of the x-ray had its beginning in America with Dr. Francis Williams, of Boston, whose early publications on this particular subject date back to 1896 and 1897. Naturally there has been a constant accumulation of new data and new methods of technique. Herein lies a necessarily close correlation of the observations of the clinician, radiologist, and pathologist. One of the very puzzling features in the x-ray study of the chest has been the difficulty of early diagnosis of tuberculosis in children. The early diagnosis of tuberculosis in adults has been very well studied and the characteristic appearance has become quite well known. This is due to the fact that adult tuberculosis is more consistent or typical in its x-ray findings than is tuberculosis in children, where the Roentgen shadows are not so distinctive. It is with pleasure, therefore, that we call attention to the recent work that has been done at the Phipps Institute for Tuberculosis, in Philadelphia. The studies at this institute have added very much to our knowledge of the behavior and appearance of childhood tuberculosis, and in this way has increased our certainty of early diagnosis.

The technique which has been useful in bringing out these helpful points requires the close cooperation of the electrical engineer, and the physiologist, with those already noted above. For it requires the development of a method which will permit very rapid exposures of the chest timed to conform to a particular phase of the cardiac cycle, a mechanical refinement to trip the switch at nearly identical phases. Formerly exposures were made quickly but without being able to choose the cardiac systole or cardiac diastole. We are not able to compare skiagrams made in different parts of the respiratory and cardiac cycles for the reason that the density of the lung shadows depends somewhat upon the quantity of blood in the pulmonary vessels at each different phase of the cardiac cycle. By this we mean that with such refinement of engineering the x-ray exposure can be made either in cardiac diastole or cardiac systole and the changes with the different parts of the cycle can be compared.

Another technical development which has helped much in the study of these cases is the lateral and oblique views of the thorax. The importance of this study, also developed at the Phipps Institute, lies in the opportunity to visualize more clearly the changes in the abnormal bronchial tree, which is usually hidden by the heart shadow, and compare the abnormal with the appearance of the normal. These refinements of x-ray diagnosis in the study of child tuberculosis are destined to be of very great importance as they are compared and studied in the light of pathologic physiology.

Such carefully controlled studies, which must be made, can offer to the fundamental fields of anatomy, pathology and physiology much information, and to clinical medicine a major opportunity for early diagnosis and adequate treatment of such diseases.

Further, in the consideration of progress in the medical sciences, particularly as related to pathology, one must give emphasis to the forte of Roentgenology in the cancer problem. It is perhaps a truism to remark that cancer is the most important medical

problem which we have to face. Students of cancer are all pretty much in accord with a second truism; namely, that success in the battle against cancer necessitates early diagnosis. We may be permitted to say further, that for this early diagnosis the x-ray is probably our most important agent. Even cursory perusal of the statistics would reveal that cancer of the lip, cancer of the tongue, and cancer of the mouth show a much more favorable outcome than cancer of the esophagus or cancer of the stomach. One does not need to argue that the greater accessibility of these parts to visual inspection is a major factor in this improvement in statistical result.

The use of barium gelatine bougies of varying sizes in the fluoroscopic examination of the esophagus enables the physician to detect very early slight obstructions in swallowing. In this way, without discomfort and without distress to the patient, the physician can ascertain the probable presence or absence of cancer at a much earlier period than he could formerly. Such observations, when critically studied in collaboration with esophagoscopy and cytopathology of the tissue changes presenting, offer a definite advance in the earlier diagnosis and treatment.

The war against cancer of the stomach is being more successfully waged each year. As we study the problem more and more, we realize that here as well the earlier the diagnosis can be made the better will be the result. It follows therefore that the success of our campaign depends to a great extent upon the efficiency of our methods of study. Again may we suggest that these methods of early diagnosis depend largely upon the intelligent use of the x-ray. Patients should be taught the advisability of seeking thorough examinations for the slight but persistent disorders of indigestion commonly called "dyspepsia." The x-ray examination of the stomach causes no discomfort to the patient. There is no reason, therefore, to procrastinate until the symptoms become markedly intrusive. By such delay the seriousness of operative procedure for relief becomes markedly greater. We must remember that the early symptoms of cancer of the stomach are often mild and deceptive, and frequently dismissed, even by the physician, with the general complaint of "indigestion." In these early cases of cancer of the stomach there is found a defect of the gastric outline, manifested either by irregularity or rigidity in the mucous membrane or muscular folds, both departures from normal being presumptive evidence of an early neoplasm. Not only does the x-ray afford a fertile method for the study of the contour and consistency of the lining and wall of the stomach, but also positive means for determining the rate at which the stomach empties. We can then observe an acceleration or retardation of the normal rate, both of which are important in the final conclusion as to the probable condition.

Statistics of the results of the treatment of cancer of the stomach show a marked increase in longevity following operative procedure, so that the older pessimism is now being succeeded by a more optimistic view. If one could insist on an x-ray examination in the average case of so-called indigestion, the brightness of the resultant outlook would certainly become considerably greater. One must, however, bear in mind that merely the use of the x-ray machine is not all that is necessary. Intelligent interpretation of the x-ray shadows, which must be based on fundamental medical knowledge and critical study, is the essential part.

Cancer of the lung must be added to this group of Roentgen diagnostic problems. For some unknown reason cancer of the lung has become much more common in the last few years. A variety of explanations have been offered for this, but so far none have been satisfactory. The diagnosis has usually been made late, and the x-ray has not been of value alone in making an early diagnosis. There is a possibility that the adjuvant of iodized oil for which appreciation must be rendered Doctors Sicard and Forestier, may offer the Roentgenologist assistance by a demonstration of beginning changes in the bronchial lumen, and the patient some hope of relief. This preparation which has been developed within the last few years is easily introduced into the body cavities. And without producing irritation it will give delightfully clear x-ray shadows of the lumen of the cavity. For example, when this oil is introduced into the bronchial tree it causes practically no irritation, and yet will cause shadows which outline that portion of the bronchial tree exactly. In the disease known as bronchiectasis, where there is a very definite enlargement and infection of the bronchi, the physical findings of a tuberculosis and chronic bronchitis are often very difficult to differentiate. However, if the iodized oil is introduced, the size and saculations of the bronchioles are made out with extraordinary accuracy. Many cases of bronchiectasis are in this way diagnosed and treated by methods which are appropriate. Further, this iodized oil is of great value for the injection of small sinuses which, when filled with it, are clearly outlined on the x-ray plate. This same iodized oil may be diluted about 50 per cent. with olive oil and injected into the nasal sinuses such as the antrum, frontal sinuses, etc. A study of the x-ray plates made after injection offers evidences of lack of filling due either to inflammatory diseases or, frequently, to tumors. Comparison with biopsy or surgical specimens may afford us further advance in

the correlation of cyto-pathology and physiology with clinical signs.

Another striking use of the iodized oil is the injection of such bland media into the uterine cavity to demonstrate its outline or the possible inclusion of tumors and to display the size of the lumen and the patency of the Fallopian tubes.

In a discussion of the function of Roentgenology in the study of neoplasms one must not overlook the advances which have been made in the field of neurology. Many brain tumors are very frequently without localizing symptoms. One can frequently feel quite sure of the presence of a brain tumor without being positive as to upon which side it is located, and what particular nerve tracts are involved. In conditions of the brain where there has been a disturbance of the circulation in the ventricles and in the lymphatic system, the x-ray is often of the greatest help. Inasmuch as many brain tumors are attended with disturbance of the collection of fluid in the ventricles, and its evacuation, there follows that many brain tumors could be delineated by the demonstration of this disturbance in a graphic method using the x-rays. The way in which this is effected, in general, is that the ventricles of the brain are tapped under very stringent aseptic precautions and the ventricular fluid is replaced by air. Films are made in different positions so as to show the air-filled ventricles in different angles. These studies of the brain oftentimes show the dilated or distorted ventricles by means of this change in density due to the injected air. Tumors, therefore, which encroach upon the ventricles to produce pressure or distortion are demonstrated. This procedure of ventriculography is one which is not used unless the symptoms are urgent. When, however, an experienced neurologist is confronted with the symptoms of a brain tumor the location of which is not certain, one feels that there is ample justification for an injection of air, which will usually be absorbed in a few days without great risk. It is a procedure which is not, of course, to be undertaken by any one who is not thoroughly familiar with all the various minutiae of the new technique. This must entail careful preliminary laboratory investigation, as has been done by Dandy, Cushing, and others.

The injection of air by way of the spinal column is also one of the newer procedures which is adding much to the study of many of our obscure brain cases. This means, like the one just referred to, is not one to be undertaken except by a thoroughly experienced investigator of the conditions and who has exhausted all the simpler methods of diagnosis. In this the cerebrospinal fluid is replaced by air, the amount of spinal fluid withdrawn being balanced very carefully by the amount of air which is being introduced so that a nearly constant pressure is maintained. X-ray plates are then made with the patient in different positions so as to study the places where the air collects or is blocked. The injection of air directly into the ventricles is spoken of as ventriculography. The injection of air into the spinal column is spoken of as encephalography, and is frequently resorted to now in the study of epilepsy, and for the demonstration of spaces resulting in the brain from previous injury.

We would like to refer briefly to the examinations of the urinary tract. When one compares the difficulties of examinations of a generation or of two generations ago with what is being done at the present time, he feels that there has indeed been great progress made. Careful clinical study, cystoscopic examination, laboratory examination of the excretions of the urinary tract, together with x-ray plates of the involved organs, either with or without the injection of an opaque solution into these viscera, detecting distortions or areas of calcification, have increased the reliability of diagnosis of tumors and dysfunction of the urinary tract manyfold. The skiagrams in such studies offer most conclusive information.

Notable among recent advances in medical science is the linkage of Roentgenology with physiology, pharmacology and biochemistry in the work of Graham and his associates, first published in 1923, on the function of the liver and biliary passages, and their Roentgengraphic demonstrations. The study and development of the utilization of halogen compounds of phenolphthalein as a test of liver and gall-bladder functions has a definite remarkable importance in the entire field of medicine to-day. With this adjunct—cholecystography—the physician is able to visualize and evaluate the function of another of the important viscera in the problem of human illnesses. The collaboration of the chemist in the production of an isomer of the salt of lessened toxicity and greater value as an index of function is most notable. Related work is being carried on in the study of the effects of various drugs on the movements of the intestinal tract in the laboratory animal, a procedure which heretofore necessitated surgical technique and often loss of the animal, together with considerable outlay in apparatus. With the fluoroscope and serial skiagrams the animal may be studied time and again under many variants in conditions. Such study under adequate experimental control will offer the most opportunity for further progress in diagnosis and intelligent therapy.

Treatment of disease by means of x-radiation is entering upon a period in which, with the collaboration of the biophysicist, we may be able to offer relief, if not cure, to the patient. The translation of amounts

of radiation energy into terms of quantity usable on all types of generators has been a serious problem. The biological dose has been in general the only "measuring stick," and there a human error in interpretation has vitiated much work. The development of a biophysical quantity will afford some further knowledge of the process which has taken place in irradiated tissue. With the establishment in the last year by the International Congress of a physical unit of the *r*, or Roentgen unit, there is in sight a standardization of x-radiation dosage on a uniform scale. This is of value both in diagnostic exposures and in therapy. The collaboration of the Bureau of Standards in maintaining a standard scale is a further step forward toward a universal standard of measurements.

With the continuance of the interest and the close cooperation and enthusiasm of the physicist, the biologist, and the Roentgenologist in the study of the effect of x-radiation on tissue, and its relation especially to the combat of the neoplasm, we may anticipate much of value to medicine and *"les malades,"* and of interest to science as a whole.

OBITUARY

MATTHEW FONTAINE MAURY[1]

FINE Virginia blood flowed in the veins of Matthew Fontaine Maury. His grandfather, James Maury, was an Episcopal clergyman who kept a small school in Albemarle County, which numbered among its pupils Jefferson, Madison and Monroe, three distinguished presidents of the United States who had much to do with starting out the University of Virginia in the way that it should go. Born in 1806, the fourth son in a large family, he soon imbibed among pioneer surroundings courage and self-reliance, a love of honor and independence of thought, and, best of all, a burning desire to know and to achieve. In a curious manner he became interested as a boy in the study of mathematics, which was to play such an important part in his future life. He relates the incident in these words, "My first ambition to become a mathematician was excited by an old cobbler, Neal by name, who lived not far from my father's house, and who used to send the shoes home to his customers with the soles all scratched over with little x's and y's."

At the age of nineteen, he became a midshipman in the United States Navy, and his first cruise was on the *Brandywine,* which carried back to France the great Lafayette after his memorable visit to the United States. Maury started his career with a determination to overcome all obstacles, no matter how disagreeable the task. The success he had in life was attained not so much by a great brilliancy of mind but rather as the result of sheer hard work. In his own words, he says:

> When I became old enough to reflect, it was the aim at which all my energies were directed to make myself a useful man. I soon found that occupation, for some useful end or other, was the true secret of happiness. . . . When I went on board ship, I set out to make everything bend to my profession. I was required to study Spanish; and that nothing might be lost, I got a Spanish work in navigation and studied that. . . . I used to draw problems in spherical trigonometry with chalk on the shot, and put them in the racks where I could see them as I walked the deck.

So well did he school himself by these methods that when his book on navigation was published in 1836, the first nautical work ever to come from the pen of an American naval officer, it soon became the standard treatise on the subject.

The navy of one hundred years ago was unfortunately in a condition of dry rot, and some one with courage was needed to come forward and point out the remedies. Maury accepted the challenge and wrote a series of articles dealing with reforms. At first he wrote under a pseudonym, but he soon won the sympathy and approval of the officers of the Navy. So excellent were the reforms suggested that when the author became known, the President of the United States had all but decided to allow him to put his theories into practice by making him the Secretary of the Navy, in spite of the fact that his rank was but that of lieutenant.

So famous had his writings made him by this time that he was appointed in 1842 as head of the Depot of Charts and Instruments. Here was the opportunity for Maury to show his worth. When he took charge, the office was a very small one, but it grew quickly in size and importance until its name was changed to that of the United States Naval Observatory. The superintendent, although a naval officer, knew little of the science of astronomy. With characteristic determination he immediately started out to teach himself. To those of us who are familiar with telescopes vastly greater than he had ever dreamed of, it is interesting to read the enthusiastic manner with which he describes the passage of a star through the field of view of a transit instrument. His enthusiasm and his love of work affected his subordinates to such a degree that soon the Naval Observatory took rank with the two national observatories of

[1] Address given on the occasion of the unveiling of his bust at the Hall of Fame of New York University, May 14, 1931.

Europe, founded nearly two centuries earlier, Paris and Greenwich.

In addition to his ability to do hard work, Maury was fortunately gifted with a lively imagination. He, therefore, planned for the Naval Observatory a very ambitious scheme, that of making a catalogue of all the stars down to the tenth magnitude that could be seen from the latitude of Washington. This comprehensive project was too great a task for any one observatory to handle and so perforce it was necessary to await the time when it could be taken up by many observatories working in cooperation. Such a catalogue was actually completed some fifty years later under the auspices of the Astronomische Gesellschaft, or German Astronomical Society. Maury was superintendent of the Naval Observatory for nearly twenty years, resigning his post at the outbreak of the Civil War.

His name is best known to us now from the pilot charts issued each month at Washington, at the top of which are found these words, "Founded upon the researches made and the data collected by Lieutenant M. F. Maury, U. S. Navy." In the year 1831 he was appointed sailing master of the *Falmouth*. Before proceeding to Rio he had sought from all the books available information on the winds, weather and currents likely to be found on the cruise. Search as he would there was no published information. Maury had a brilliant thought, beautifully described by one of my colleagues at the University, which was that, "the sea, if investigated, would be found to have its laws as constant, as uniform, as invariable as those of the land. Nature was to Maury one and indivisible. She was as sovereign over the three fourths of the world which was fluid as over the one fourth which was solid. The waves, the winds, the storms, the currents, the depths and the temperatures of the sea were believed by Maury to constitute a system, a complex of cause and effect, constant in its regularity, perfect in its orderliness, and so mathematically interrelated that the mind of man could by patient investigation understand its phenomena and ever forecast its processes."

Maury determined to make the sea give up her secrets by observing her vagaries. His own observations on his trip to Rio availed but little. Many observers spread over many seas and over long intervals of time were needed. But how to secure them, and how wait patiently while the observations were being accumulated? Help came from an unexpected quarter. In the observatory offices where Maury went in 1842 there was a collection of what was regarded as so much rubbish, old log books of past generations of naval vessels, apparently fit only for a bonfire. It took five years of hard work to bring order out of chaos, and it was not until 1847 that he published his first "Wind and Current Chart." But what good were his precepts? Were they only the vapid musings of a fossilized old astronomer, or would the time of passage of a ship from one port to another actually be shortened? That was the real test. And what a triumph was in store! The average voyage by a sailing vessel from New York to Rio had been 55 days. By following Maury's directions, a barque early in 1848 on its trip south made the voyage in 35 days and returned in 40 days. When ship captains found that they could have a copy of his sailing directions by agreeing to make observations and to send them in to Washington, Maury was able to write that by 1851 he had more than one thousand ships in all the oceans observing for him.

Gold was discovered in California in 1849. In rushing supplies from New York to San Francisco, 15,000 miles distant, time was undoubtedly money. The average voyage was 180 days. The clipper ships of those days had exciting races. As Maury wrote, "Some of the most glorious trials of speed and prowess that the world ever witnessed, among ships that walk the waters, have taken place over it. Here the modern clipper ship—the noblest work that has ever come from the hands of man—has been sent, guided by the lights of science, to contend with the elements, to outstrip steam and astonish the world." Many ships made the voyage in 110 days, the record for a clipper ship is 90 days.

It has been estimated that Maury's charts made an annual saving to the commerce of the United States of those days of more than two million dollars, while British commerce saved each year the sum of ten million dollars.

Maury's fame was still in the ascendancy. In 1853 an international congress was held in Brussels, the first League of Nations. At its close Maury's charts were adopted and plans were made for further cooperation by nineteen twentieths of the shipping of the world. Transatlantic sea lanes were adopted which have remained almost unchanged to the present. One year after the conference had met he published the first depth map of the North Atlantic and he later assisted in laying the first Atlantic cable. In 1855 he published his "Physical Geography of the Sea" and inaugurated a new science.

He strongly urged that systematic observations of weather conditions should be made all over the United States and the results be telegraphed to a central bureau. Political jealousies retarded this movement and it was not until many years later that the U. S. Weather Bureau was organized. Maury has been frequently referred to as the father of the U. S. Naval Academy.

Scientists when great are usually modest. Sir Isaac Newton was buried in Westminster Abbey with royal honors. Of himself he has said, "I have been but as a child playing on the seashore; now finding some pebble rather more polished and now some shell more agreeably variegated than another, while the immense ocean of truth extended itself unexplained before me." And so it was with Maury. He did not lay claims to great discoveries. "I only bring together," he wrote, "the observations that others have made, and then leave it to the observations themselves to discover their own meaning in their own way."

His life should be an inspiration to every youth of to-day, showing as it does so clearly that hard work, with enthusiasm and imagination, will overcome nearly all difficulties.

S. A. MITCHELL
LEANDER MCCORMICK OBSERVATORY,
UNIVERSITY OF VIRGINIA

MEMORIALS

THE *Journal* of the American Medical Association states that ceremonies in memory of Fernand Widal were recently held in Paris. Professor Pasteur Valléry-Radot (grandson of Pasteur), who was a pupil of Fernand Widal and who is now an associate professor at the Medical School, delivered an address on the work of his former teacher. He described his methods of work and experimentation and recalled the discoveries for which science is indebted to him.

Nature states that at a special meeting of the council of the Ray Society on April 30, the following resolution was adopted: "The Council of the Ray Society desire to place on record the profound grief felt by them on hearing of the death of their president, Professor W. C. M'Intosh, F.R.S., on April 1 last. Professor M'Intosh had belonged to the society since 1863 and had been president since 1913. He had not only shown his practical interest in its success by his exceptionally long period of membership, but he had given the most devoted service to the society by his frequent journeys from St. Andrews to London, in order to attend the meetings of the council, at which he nearly always presided. The council direct that this record of their appreciation of the value of their late president's work be sent to Dr. R. T. Gunther, his nearest surviving relative, with the expression of their sincerest sympathy."

RECENT DEATHS

DR. SOLON IRVING BAILEY, professor emeritus of astronomy at Harvard University, from 1892 to 1919 in charge of the Arequipa branch of Harvard College Observatory, died on June 5, in his seventy-seventh year.

DR. FRANK WIGGLESWORTH CLARKE, chief chemist of the U. S. Geological Survey, *retired*, well known for his work on the constants, atomic weights, geochemistry and other subjects, died at his home in Chevy Chase, Maryland, on May 23, in his eighty-fifth year.

DR. EDWARD HART, professor emeritus of chemistry at Lafayette College, died on June 6, at the age of seventy-six years.

DR. SAMUEL W. BEYER, dean of the industrial science division of Iowa State College, was fatally hurt when his automobile was struck by a passenger train on June 2. Dr. Beyer, who was sixty-six years of age, was known for his work in economic geology.

THE death is announced of Dr. Carroll Gideon Bull, professor of immunology in the School of Hygiene and Public Health of the Johns Hopkins University.

DR. BENSON AMBROSE COHOE, professor of therapeutics at the University of Pittsburgh Medical School since 1920, died on May 27, at the age of fifty-six years.

WILLIAM DOBINSON HALLIBURTON, emeritus professor of physiology at King's College, London, died on May 21, at the age of seventy-one years.

PROFESSOR JOSEPH EDWARDS, principal and professor of mathematics and physics at Queen's College, London, died on May 30, in his seventy-eighth year.

MR. ST. GEORGE LITTLEDALE, known for his explorations in central Asia, died on April 16, at the age of seventy-nine years.

SCIENTIFIC EVENTS

RECONSTRUCTION OF THE ROYAL INSTITUTION

THE *British Medical Journal* states that the rebuilding of a considerable part of the Royal Institution became imperative some two years ago, after a series of explosions in Albemarle Street, which compelled the attention of the managers to the dangerous condition of the lecture theater. This historic room, the scene of the Friday evening discourses and experiments of Davy, of Faraday, and of a long line of distinguished scientific men over a period of one hundred and thirty years, had remained almost unchanged since it was completed under the supervision of the founder of the institution, Count Rumford, in 1802.

It was built entirely of timber, and by modern standards was very ill provided with exits. A survey made two years ago showed the fire risks to be so grave that they could no longer be ignored. Plans were prepared, and a scheme of reconstruction was undertaken. This has now been completed, and a housewarming party was held on the evening of May 6. The principal consideration in the rebuilding has been to satisfy modern standards of security by means of fireproof construction and by the provision of suitable exits; but the perfection of the design of the lecture theater for the scientific purpose for which it was built has been recognized the world over, and succeeding generations of members have held their meeting room in affectionate regard, so that it has been a particular care to effect the restoration with as little modification of its qualities and appearance as possible. Advantage has naturally been taken of the opportunity to bring the equipment up to date, and the theater has been provided with a cinematograph projector, an epidiascope, a great variety of services to the lecture table for experimental purposes, and a number of other refinements for the assistance of the lecturer and the convenience of his audience. The rebuilding of the lecture theater has involved the replanning and reconstruction of a large adjacent part of the building. On the ground floor the arrangements have been largely determined by the requirements for exit to the street from the theater above. A new entrance hall has been constructed, some of the rooms have been replanned, and a large new chemical laboratory has been built. During the evening Sir William Bragg, Fullerian professor of chemistry and director of the laboratory, demonstrated to the guests some of the classical experiments of the Royal Institution.

THE INTERNATIONAL CONGRESS FOR STUDIES REGARDING POPULATION

ORGANIZED by the Italian committee for the study of population problems an *International Congress for Studies Regarding Population* will be held in Rome from September 7 to 10.

His Excellency the Head of the Government, Benito Mussolini, has accepted the honorary chairmanship of the congress, while the effective chairmanship is entrusted to Professor Corrado Gini, president of the Italian committee.

The organization of the congress will include: (*a*) An honorary committee; (*b*) An International Committee of Patronage, composed of presidents and representatives of National Scientific Organizations for the study of population problems and other personalities who will be entrusted with the propaganda for the congress in their own countries and with the relations between the organizing committee and those engaged in these studies in the respective associations; (*c*) An Organizing Committee, composed of Italian members who will be entrusted with the organization of the congress and will be responsible for the acceptance of communications.

The program of the congress is purely scientific, so that any political, moral or religious propaganda whatever is forbidden, even if questions concerning the problems of population are involved.

For the distribution of the scientific papers the congress will consist of the following sections: Biology and Eugenics, Anthropology and Geography, Hygiene and Medicine, Demography, Economy, Sociology, History, Methodology.

Each meeting will be presided over in turn by specialists belonging to different nationalities. The congress will be open to the public. All taking part in the congress will be entitled to send communications of which the final text should reach the organizing committee before July 1.

Some subjects of special importance, chosen by the organizing committee, will be the object of reports by persons previously nominated and will be submitted to discussion by the sections.

The fee entitling to take part in the congress and to receive a copy of the proceedings is fifty lire for all those invited, whether individually, or through national scientific committees or associations, and one hundred lire for others taking part in the congress.

All those who take an interest in the congress and would like to receive the detailed program are invited to apply to the "Comitato Italiano per lo Studio dei Problemi della Popolazione."—10, Via delle Terme di Diocleziano, Roma (Italia).

RANGE RESEARCH CONFERENCE AT EPHRAIM, UTAH

THE Ecological Society of America is sponsoring a meeting for the purpose of discussing range research with particular attention to methods. The program is being planned to give opportunity for field discussions and demonstrations as well as for more formal discussions. The committee in charge of arrangements consists of C. L. Forsling, *chairman;* H. C. Hanson, Walter P. Taylor and W. G. McGinnies, *secretary.*

The tentative program includes a discussion of the following topics:

1. Methods of studying plant populations and their changes.
2. Methods of studying forage production and yield, including clipping, height growth, volume determination or other methods; clip quadrats,

their location, treatment and charting, systems of clipping, weighing, value and limitations.

3. Methods of studying plant development for seasonal use and other purposes, autecology-phenology and life histories; value and methods; period studies, panel exclosures, and other methods including procedure, measurements, equipment, value and limitations.
4. Utilization and palatability, methods of measuring and computing for different kinds of vegetation.
5. Methods for controlling the grazing factor, including isolation transects, permanent exclosures and inclosures, intermediate control inclosures and exclosures, and other fenced plots.
6. Instrumentation, essential facts to measure, instruments and analysis correlation, and presentation of data.
7. Methods of studying the influence of grazing on saw timber types.
8. Methods of studying inter-relation between grazing and erosion.
9. Methods of studying animal life, including livestock, rodents, big game, upland game birds and other birds and animals.
10. Terminology—suggestions regarding standardization—(a) standard terms, (b) open terms.
11. Plant nomenclature—(a) scientific names, (b) common names.
12. Compilation and analysis of range research data with special attention given to the use of statistical methods.

The committee hopes to prepare a detailed account covering the various topics for discussion at the meeting. In order to do this it is necessary to have available outlines of the various methods in use by different investigators. The committee would be glad to receive any suggestions as to points to be discussed and would especially like to have each investigator submit outlines or other descriptions of methods used in range research.

It would greatly facilitate matters if every one would send the secretary his own name and address and the names and addresses of others who might be interested in order that subsequent announcements may be properly sent.

THE AMERICAN INSTITUTE OF PHYSICS

PLANS for formation of a consolidated scientific organization to be known as the American Institute of Physics have been made public by Dr. Karl T. Compton, president of the Massachusetts Institute of Technology.

Both science and the public are to be served. The institution will bring together several scientific organizations now separate but having common interests. It will also knit together a great group of men in industrial laboratories and manufacturing plants who, as physicists, play a most fundamental rôle in modern industry, but who have not heretofore constituted a well-recognized unit. Also in schools and colleges, local or student branches of the institute may be found. For the public there will be a press department to explain some of the fascinating laboratory happenings which often remain masked behind unfamiliar scientific words. This will include cooperation with the press and contacts with local groups interested in physics.

The plans were started jointly by the American Physical Society, the Optical Society of America and the Acoustical Society of America. The Society of Rhedology has also joined in the movement to establish the institute and several other national as well as some local organizations have expressed interest in joining or becoming affiliated with it.

Dr. Compton is chairman of the governing board of the institute, which has been set up jointly by the cooperative societies to work out the organization problems. The secretary of the board is Dr. George B. Pegram, head of the department of physics and formerly dean of engineering in Columbia University. Other members include directors and leaders in some of the largest industrial research laboratories as well as university men.

The productivity of American research physicists has increased so rapidly that the present means of publication of their results have been quite overstrained. Hence one immediate objective of the cooperating societies is to achieve through the new institute unified and enlarged publications for research results and other information in physics, including abstracts of all published work in physics over the world. In this publication to cover the field of physics it is expected to attain a high standard of completeness and promptness. The Chemical Foundation, Inc., of New York, has offered to undertake the handling of the business end of the publication.

HONORARY DEGREES CONFERRED BY COLUMBIA UNIVERSITY

THE recipients of the honorary degrees of doctor of science at the recent commencement of Columbia University with the formulae used by President Nicholas Murray Butler in conferring the degrees were:

JAY DOWNER, chief engineer of the Westchester County Park Commission—Native of Iowa; graduated at Princeton University with the class of 1905; for some twenty years associated as planner and leader with the development of the neighboring county of Westchester; a singularly high type of public servant, endowed with that vision and courage which multiply

the force of his engineering ability and which so well equip him with the skill to unite the useful and the beautiful.

LUTHER PFAHLER EISENHART, dean of the faculty of Princeton University—Native of Pennsylvania; studying first at Pennsylvania College and then at the Johns Hopkins University; preparing himself by intensive work in mathematics for the scholarly labors which he now pursues; trusted and competent adviser of undergraduate youth; a powerful force in the work of the Princeton University of to-day, that sister university and honored neighbor which, like our own King's College, traces its origin to an original charter granted by authority of George II.

CHARLES JUDSON HERRICK, professor of neurology in the University of Chicago—Native of Minnesota; trained at the University of Cincinnati, at Denison University and at Columbia; eagerly pursuing advanced study and research in his chosen field with marked success; recipient of many honors from his fellowmen of science; fertile and suggestive writer on biological and neurological topics; for well-nigh a quarter century a distinguished member of the University of Chicago.

ARTHUR DEHON LITTLE, chemical engineer—Native of Massachusetts; a captain in the organization and direction of research in the science of chemistry in all its manifold revelations; covering in his field of interest and influence almost every aspect of chemical engineering practice; fertile in invention, practical in application and a genuine leader in the preservation and advancement of that organized body of knowledge which we know as science; one who, as even Sir Humphry Davy would admit, pursues science with true dignity.

SCIENTIFIC NOTES AND NEWS

THE annual list of honors conferred on the occasion of King George's birthday included the Order of Merit on Sir William Henry Bragg, Fullerian professor of chemistry and director of the Royal Institution.

LORD RUTHERFORD has been elected president for the year 1931–32 of the British Institute of Physics.

DR. JAMES HENRY BREASTED, director of the Oriental Institute of the University of Chicago, has been elected a foreign member of the Bavarian Academy of Sciences.

ON the occasion of the fifty-ninth annual commencement of Stevens Institute of Technology at Hoboken, New Jersey, the doctorate of science was conferred on Dr. Karl T. Compton, president of the Massachusetts Institute of Technology, who delivered the commencement address.

AT the recent commencement of Wake Forest College, the degree of D.Sc. was conferred on Dr. Hubert Royster, lecturer in Duke University, formerly dean of the Raleigh division of the Medical School of the University of North Carolina.

DR. PHILIP FOX, director of the Adler Planetarium, Chicago, received an honorary doctorate from the Kansas State Agricultural College on the occasion of its sixty-eighth annual commencement in May 28.

THE University of Göttingen has renewed after fifty years the doctorate degree of Dr. Stephen Moulton Babcock, professor of agricultural chemistry at the University of Wisconsin. In transmitting the renewed diploma through Professor Karl Freudenberg, who is the Carl Schurz professor of chemistry at the university, Dr. Wilhelm Seedorf, dean of the University of Göttingen, called special attention to the fact that the work of Dr. Babcock has been of great significance to German agricultural scientists, and that his work is held in very high esteem. The diploma, presented to Dr. Babcock in the presence of a group of his immediate associates and friends, reads as follows: "Under the jurisdiction of his excellency, the rector, Johannes Behm, the mathematical and natural science faculty of the George August-University renews through its dean, Professor Dr. Wilhelm Seedorf, the diploma of doctor of philosophy degree, dated February 28, 1879, granted to Mr. Stephen Moulton Babcock, the extraordinarily distinguished investigator in the chemistry and bacteriology of milk and therefore of agriculture in general, and extends its heartiest greetings and wishes for a continued happy old age."

AT the commencement exercises of Tuskegee Institute, at Tuskegee, Alabama, a bronze bas-relief was unveiled of Dr. George W. Carver, director of the Agricultural Experiment Station at Tuskegee and consulting chemist. Dr. Carver has been working in botany and agricultural chemistry at Tuskegee for thirty-five years.

THE council of the British Institution of Electrical Engineers has made, as reported in *Nature*, the following award of premiums for papers read during the session 1930–31, or accepted for publication: the institution premium to Commendatore G. Bianchi, Ayrton premium to R. Grierson, John Hopkinson premium to J. W. Rissik and H. Rissik, Kelvin premium to B. L. Goodlet, F. S. Edwards and F. R. Perry, Paris premium to P. J. Ryle, and extra premiums to W. E. M. Ayres; R. M. Charley; H. S. Carnegie; D. B. Hoseason; Dr. J. J. Rudra and Professor Miles Walker; Professor W. Cramp and A. P.

Jarvis; P. J. Higgs; J. C. Prescott and E. W. Connon; G. G. Smail, R. J. Brooksbank, and Professor W. M. Thornton; Professor S. P. Smith; and Professor E. Wilson. In the Wireless Section, the Duddell premium has been awarded to T. Walmsley and extra premiums to C. E. Horton and C. E. Rickard. In the Meter and Instrument Section, the Silvanus Thompson premium has been awarded to Professor W. M. Thornton, M. Waters and W. G. Thompson, and an extra premium to E. W. Hill and G. F. Shotter.

THE daily press reports that the appointments of twenty members of the faculty of the University of Kansas have not been renewed. Among these is Dr. A. A. Schaeffer, professor of zoology.

THE title of emeritus professor has been conferred on Sir Charles J. Martin, professor of experimental pathology, and Dr. Arthur Hardin, professor of biochemistry, of the University of London.

DR. FRANK LUSK BABBOTT, JR., has been appointed president of Long Island College of Medicine, Brooklyn, to succeed Dr. James C. Egbert. The newly appointed president will assume his full time duties on July 1. Dr. Babbott, who has been associated with the department of pediatrics at the medical college for several years, has been assistant professor of pediatrics and assistant dean since 1927. He received his M.D. degree from Columbia University College of Physicians and Surgeons in 1918.

DR. CARROLL WILLIAM DODGE, assistant professor of botany and curator of the Farlow Library at Harvard University, has been appointed professor in the Shaw School of Botany at Washington University.

DR. GEORGE B. CRESSEY, formerly of Shanghai College, China, and at present at Clark University, has been appointed head of the department of geology, mineralogy and geography at Syracuse University. This new department represents a union of the work in geology, formerly under Dr. Thomas C. Hopkins, who retires this year, and mineralogy under Dr. Charles H. Richardson, who continues as senior professor.

DR. PATRICK H. YANCEY, instructor in biology in St. Louis University, has been appointed professor of biology and director of the department at Spring Hill College, Mobile, Alabama.

DR. EDWARD F. MCCARTHY has been appointed head of the department of silviculture of the New York State College of Forestry at Syracuse. He was formerly a member of the college faculty and succeeds the late John W. Stephen.

MR. A. E. NAISH, physician to the Sheffield Royal Hospital and lecturer in medicine in the University of Sheffield, has accepted the invitation of the council of the University of Edinburgh to become professor of medicine.

DR. WALTER R. KIRNER has resigned his position as assistant professor of organic chemistry at the Rice Institute, Houston, Texas, to accept a position as organic chemist on the staff of the Coal Research Laboratory of the Carnegie Institute of Technology. His new duties at Pittsburgh will include the organization of a laboratory for quantitative micro-organic analysis.

MR. JAMES F. WALSH, formerly vice-president and technical director of the Celluloid Corporation, has joined the consulting staff of Arthur D. Little, Inc., of Cambridge, Massachusetts.

THE American Standards Association has announced the appointment of H. M. Lawrence, mining engineer, and S. W. Benham, as assistant engineer, on the staff of the association. Mr. Lawrence will have supervision of all the mining, chemical and ferrous and non-ferrous metallurgical projects being developed under the procedure of the association. Mr. Benham will assist in the supervision of civil engineering and transportation projects. Mr. Lawrence has been mining engineer with the International Agricultural Corporation. From 1924 to 1930 he was connected with the U. S. Bureau of Mines as metallurgist. Mr. Benham has been connected with the Portland Cement Association and with the Johns-Manville Corporation.

WE learn from the *Journal* of the American Medical Association that Dr. Clarence L. Scamman, Boston, has resigned as deputy commissioner of public health of Massachusetts and director of the division of communicable diseases, to become director of the division of public health of the Commonwealth Fund of New York, succeeding Dr. William J. French, resigned. He will have charge of the development of rural health service in various states. Dr. Scamman was given a farewell dinner, May 1, at the Harvard Club of Boston by friends and coworkers and presented with a traveling bag. Dr. George H. Bigelow, commissioner of public health, presided. Dr. Gaylord W. Anderson will succeed Dr. Scamman, and Dr. Nels A. Nelson will succeed him as assistant director of the division of communicable diseases.

PROFESSOR C. H. DESCH has been appointed superintendent of the metallurgy department of the British National Physical Laboratory, in succession to Dr. Rosenhain. Professor Desch, who is a fellow of the Royal Society and of the Institute of Chemistry, is at present professor of metallurgy and dean of the faculty at the University of Sheffield. He will

not take up his new appointment until February, 1932, as he had previously accepted an invitation from Cornell University to give a course of lectures there during the winter session of 1931–32.

DEAN HUGH P. BAKER, of the New York State College of Forestry at Syracuse University, has been appointed a delegate to represent the college at the International Conference on Forestry to be held in Paris, from July 1 to 4.

PROFESSOR H. S. JENNINGS, of the Johns Hopkins University, is to spend the academic year 1931–1932 as visiting professor at the Keio University, Tokyo, Japan. His address until June 30, 1932, will be Medical School, Keio University, Tokyo, Japan.

DR. H. W. STUNKARD, professor of biology at New York University, has been granted sabbatical leave from the university for the academic year 1931–32. For this period he has been awarded a fellowship of the Guggenheim Foundation to continue his researches on the biology and life history of certain parasitic flatworms in European laboratories. He is sailing the latter part of June and will spend the major portion of the time with Professor F. Fülleborn, in the Institut für Schiffs- und Tropenkrankheiten, Hamburg.

DR. JOHN S. KARLING, professor of botany at Columbia University and physiologist of the Tropical Plant Research Foundation, Washington, D. C., sailed on May 22 for British Guiana to continue his research work in the tropics. This is the eighth expedition he has undertaken to tropical America as director of the Chicle Research Project. At Tower Hill in the Orange Walk District an experiment station and plantation of more than fifty thousand acres have been established in efforts to evolve a new system of tapping the sapodilla tree which will make it more suitable for plantation culture.

DR. NEVIL V. SEDGWICK, of Lincoln College, Oxford, spoke at Iowa State College, June 3, on "Divalent Carbon."

PROFESSOR W. M. DAVIS has lately given five lectures on "The Coral Reef Problem Treated in Illustration of Scientific Method" to students of the department of geology of Stanford University, where he is also conducting an advanced course in physiography during the spring term.

THE installation of Dr. Charles Chester McCracken, who succeeded Dr. George Alan Works as president of the Connecticut Agricultural College at Storrs a year ago, took place on June 6. The exercises also marked the fiftieth anniversary of the college. Governor Wilbur L. Cross presided at the inauguration and inducted Dr. McCracken into office. Addresses were made by Dr. W. O. Thompson, president-emeritus of the Ohio State University, and by Dr. McCracken. The baccalaureate sermon on Sunday was delivered by Dr. McCracken, who spoke on "The Potter and His Clay." The commencement address on June 8 was given by Professor Edmund W. Sinnott, of Columbia University, who was formerly professor of botany and genetics at Storrs.

APPLICATIONS for the position of associate biochemist (fungicide investigations) must be on file with the U. S. Civil Service Commission at Washington, D. C., not later than July 10, 1931. The examination is to fill vacancies in the departmental and field services. The entrance salaries range from $3,200 to $3,800 a year. Competitors will not be required to report for examination at any place, but will be rated on their education, training, experience and writings. Applicants must have been graduated with a bachelor's degree from a college or university of recognized standing, with major work in chemistry, and, in addition, must have had at least three full years of graduate study or productive research experience in physical chemistry, including plant colloids and physical properties of solutions. Applicants also must have demonstrated ability in devising laboratory methods and equipment.

THE Royal Photographic Society of Great Britain is holding its seventy-sixth annual exhibition in London in September and October of this year. This is the most representative exhibition of photographic work in the world, and the section sent by American scientific men heretofore has demonstrated the place held by this country in applied photography. It is hoped that the scientific section will be thoroughly well represented in 1931, and in order to enable this to be done with as little difficulty as possible arrangements have again been made to collect and forward American work intended for the scientific section. This work should consist of prints showing the use of photography for scientific purposes and its application to spectroscopy, astronomy, radiography, biology, etc. Photographs should be mounted but not framed. They should be sent at once to A. J. Newton, Eastman Kodak Company, Rochester, New York.

AT a three-day field conference of professional geologists at the Pennsylvania State College, it was decided to effect an organization to promote pure and applied geological research in the state, and to encourage future field studies by the group. Professor C. A. Bonine, head of the department of geology at the college, will lead the second field conference which will be held in the Lehigh Valley with Lafayette College and Lehigh University acting as the hosts.

DISCUSSION

THE ACCURACY OF WIRELESS TIME SIGNALS

THE purpose of this communication is to give a brief account of the accuracy to be expected of the time signals offered by American broadcasting stations. No attempt will be made here to discuss the relative accuracy of the time signals broadcast by various observatories scattered over the earth, nor will the advantages and disadvantages of the differing methods used by these observatories in relaying signals be considered. Persons primarily interested in these "official" time signals will find much valuable information concerning them in the "Handbook" for 1931 of the British Astronomical Association.

The data on which the following discussion is based were gathered during the past two and a half years and include more than 500 comparisons of signals from fifteen broadcasting stations. The comparisons were made using a stop-watch which reads to fifths of seconds and a watch of fairly uniform rate. The latter was compared regularly with the time signals from the U. S. Naval Observatory at Washington, D. C., a short-wave receiving set being used to pick up the signals.

There are three common ways of announcing the time to the listening public. One is to have the announcer state that "It is now *exactly* one fifty-nine and one half, Eastern Standard Time by the celebrated Blank watch." Another method is to use a bell or a chime, preceded by an announcement such as: "When you hear the musical note, it will be exactly two minutes after two P. M., Central Standard Time." The third method is to use a superimposed tone beat every hour on the hour and, in some cases, also on the half hour. Ordinarily there is no warning that this beat is coming.

The first of these methods has been found to be the least precise in practice. Even though the announcer may place considerable emphasis on the word "exactly," such announcements are often fifteen seconds in error, and sometimes are wrong by a minute or more. A good seventeen-jewel watch set once a week by some accurate wireless time signal will prove more reliable as an authority on time than the average signal of this sort.

Signals from broadcasting stations using the second method are usually quite accurate. The name of the company sponsoring the signals has been found to be a good indication of the accuracy to be expected. One company sponsoring signals over a number of stations has provided signals which are almost never more than five seconds in error while the numerical average of their errors has been found to be slightly less than one second. Another company provides signals which are seldom less than ten seconds in error and on the average are in error by about twenty seconds. The use of a gong, bell or musical note for time announcements as inaccurate as these must be considered as misleading, if not actually dishonest. Fortunately this situation is not common in practice and one can generally rely on "gong" signals being less than five seconds in error.

The superimposed tone beats every hour on the hour ordinarily provide the most accurate time signals excepting those originating in an observatory. Some broadcasting stations using this form of signal maintain an accuracy that is really surprising, the error of their signals invariably being less than one second. In general one may reasonably expect the error of superimposed tone beats to be less than three seconds. There are, however, two criticisms to be made of this type of signal. The first has already been mentioned, namely, that the signals come without warning. The second is that occasionally a station will temporarily discontinue this service. This criticism does not apply to most stations offering this type of signal, but some stations are notoriously undependable in this respect.

These three types of signals offer a great service to the American public. There can be little doubt that their accuracy is sufficient for most purposes. Only jewelers, astronomers and perhaps a few others have need for greater accuracy and these can easily arrange to receive the time signals of some observatory.

CHARLES H. SMILEY

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RECENT CLIMATE AND VEGETATION A FACTOR IN THE MOUND-BUILDING CULTURES?

WHETHER one sees much or little in the problem of ethnic identity of the mound-builders, there seems to be no question that the Hopewell culture at least represents a higher level than anything else known in the north-central states.[1] Certainly, too, the finest works and the artifacts associated with them were not being produced at the time of white exploration, whatever the blood kinship of their authors might have been. It also appears to be conceded that the flowering of these better cultures rested upon the basis of a successful maize agriculture. As mapped by Shetrone[2] the western limits of the northern mound culture are essentially those of the present corn belt, but the

[1] H. C. Shetrone, "The Mound-Builders," p. 479, 1930.

[2] *Ibid.*, p. 28.

highest expression, namely, the Hopewell, lies well toward the east in this area.[3]

Without binding oneself to the thesis of Huntington,[4] that climates virtually control civilization patterns, it may be well to note that middle western climate has been until recently much less humid as judged by vegetation than it is to-day. This fact has been developed quite independently of parallel evidence in Europe. It was first established on good floristic grounds by Gleason, whose most recent paper[5] gives an excellent summary. Meanwhile Auer,[6] in Canada, and the present writer and his students, working in Iowa and the Erie Basin,[7] have secured good confirmatory evidence from a microscopic study of recent peats. Additional confirmation is afforded by a recalculation of the results reported by Lewis and Cocke[8] for the Dismal Swamp of Virginia.

Making due allowance for all the difficulties and sources of error involved in reconstructing past climates, it may be safely stated that until a few hundred years ago the characteristic vegetation of the corn belt lay considerably to the eastward, and has since shifted west. Many other details of postglacial climate are still highly debatable, but this at least appears well enough established to merit attention from all who are concerned in interpreting biological phenomena in the United States. The westward swing of such conditions in recent centuries was accompanied by an advance of the humid deciduous forest from south and east. Did this favor cultures which lived largely by war and chase as against those more dependent on tilling the soil (without the aid of steel tools and draft animals)? Did this change become effective before or with the great interior displacement of American tribes caused by white pressure and bartered firearms from New England and Dutch New York?

Any causal explanation which the writer might advance would be mere conjecture. But the fact remains that the cultural climax of the northern maize civilization occurred toward the east of the present corn belt, and at a time when corn-belt conditions were in all likelihood east of their present location.

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[3] *Ibid.*, p. 187.
[4] E. Huntington, "Civilization and Climate," 2nd Ed. 1922.
[5] H. A. Gleason, "The Vegetational History of the Middle West," *Ann. Assoc. Am. Geog.*, XII, 39–85, 1922.
[6] V. Auer, "Peat Bogs in Southeastern Canada," *Mem.* 162, Geol. Surv., Can., 1930.
[7] Inv. Manuscript read before Syst. Sec. Bot. Soc. Am., December, 1930.
[8] Lewis and Cocke, "Pollen Analysis of Dismal Swamp Peat," *Jour. Elisha Mitchell Soc.*, 45: 37–58, 1929.

TYNDALL BEAM INTENSITY OF TURBID COLORED SOLUTIONS

MOST of the work on the Tyndall beam intensity of turbid solutions has been carried out with dispersions in colorless media, or in such a way that the absorption due to the dispersion medium could be neglected. P. V. Wells has shown (*Chemical Reviews*, 3: 331) that under these conditions the Tyndall beam intensity is a power function of the depth or the concentration as a first approximation. The writers have used the Pulfrich photometer, manufactured by Zeiss, to investigate the turbidity in a colored raw sugar, in solutions of varying depth and concentration. Under these circumstances a correction must be applied for the absorption due to the coloring matter. It was found experimentally that Wells' equation holds if there be substituted for the Tyndall beam intensity itself, the ratio between it and the percentage transmittancy of the same solution, measured in the same absorption cell and at the same wave-length. For equal concentration at varying depth, or for equal depth at varying concentration, the exponent in the formula is independent of wave-length. The detailed results of this investigation, which is being continued, will be published elsewhere.

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THE CURVATURE OF SPACE

IN an address made at the dinner in honor of Professor Einstein at the California Institute of Technology, Professor Frederick H. Seares made some very interesting remarks about the curvature of space. After explaining how Einstein has shown us that we may with advantage change some of the rules of world building, he makes the rather astounding assertion "that curved space means only a new set of rules which require that measurements be made along curved lines." The layman will no doubt exclaim, "Well, I thought they were offering me a camel to swallow, but it turns out to be only a gnat." For, of course, we can make measurements in space in any way we like. From time immemorial astronomers have measured the course of a planet or comet traveling along its orbit, be it an ellipse, parabola or hyperbola. It hardly required the insight of an Einstein to discover that fact.

To make matters still clearer Professor Seares brings up the time-honored illustration of measuring distances along the earth's surface. Of course we would naturally measure the distance from Pasadena to New York on a great circle, or more likely by the actual route traveled by our railroad train—a decidedly crooked path. But suppose we wished to use this distance as a base line to find how far away the

moon is, we should then have to measure the chord connecting the two places—a straight line.

The gist of Professor Seares's remarks then seems to be that by discarding the straight line and making our measurements in space along curved lines we can "win the game with a score we could not otherwise attain." Curved lines, however, imply the existence of straight lines, and some of us still believe the game can be won by straight measurements and straight thinking.

JERMAIN G. PORTER

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CONICAL SNOWFLAKES

WITHIN the writer's observation, at least, a very unusual snowfall occurred in Ann Arbor on Sunday afternoon, April 26, 1931; during the afternoon three main falls occurred, each lasting for only a short while, and each yielding but little actual precipitation.

The crystal formation was that of a solid cone with a round base. The side of the cone made an angle of about 30 degrees with the axis. The round base was part of a spherical surface. The shape was exactly like that of a conical section of a sphere.

As nearly as the eye could see into the formation of a snowdrop, the whole structure seemed to be made up of conical needles, packed together, with the upper ends forming the pointed tip of the cone, and the larger lower ends forming the rounded base.

The density was very high; a handful of snow, slightly compressed, immediately formed soft ice. The ratio of snow volume to volume when compressed to ice without air included would hardly have been higher than four to one.

Hundreds if not thousands of individual snowdrops came under observation on a window sill; irrespective of size, from tiniest to largest, the crystals were of the same form. In spite of landing on the stone sill at high speed in the high wind, nearly all crystals were tough enough to retain their shape; such few observed crystals as were shapeless were almost certainly shapeless only due to damage from impact.

The shape of the snowdrops was the same in all three falls, although the three falls occurred from a half hour to an hour apart. Many large crystals fell; one of the largest, by actual measurement, was three eighths of an inch across the base.

The day was very gusty, with rapid changes in wind velocity. Wind velocity at times during the snowfall became very high. There were rapid alternations between brilliant sunshine and considerable cloudiness. The temperature was mild. Most of the snow would melt in a few minutes, although an inch or two that became piled on the running board of a car was there the next morning, partly melted, but with somewhat globular outlines still visible.

Observation of the shape of crystals was checked by Professor William Stout.

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THE LABRADOR CURRENT AND ICEBERGS

I NOTICE on page 12 of the May 15th number of *Science Supplement* an article on "The Labrador Current and Icebergs."

In explaining this phenomenon it might be well to consult the Weather Bureau records at Key West and Havana with respect to the direction and velocity of the wind this winter as compared with normal winters.

It is my observation in the months of November, January and February that the usual northeast winds, referred to there as the "trade winds," were absent a great deal of the time and were replaced by northwest winds of very considerable velocity.

A northeast wind blowing counter current to the flow of the Gulf Stream at the south end of Florida would tend to slow down the Gulf Stream. If this atmospheric resistance to flow was eliminated one would expect the Gulf Stream to speed up and carry more heat to the north.

IRÉNÉE DU PONT

WILMINGTON, DELAWARE

THE IMMEDIATE PROBLEM FOR BIOLOGICAL ABSTRACTS

A VICIOUS circle exists in the affairs of *Biological Abstracts*. This publication finds difficulty in obtaining a maximum number of subscribers because it is incomplete and indices have been delayed; it can not become complete and indices be published without the financial support available directly and indirectly from a maximum number of subscribers.

Under the general conditions existing in the biological sciences, we can hope to pay by subscriptions only for printing and similar costs. Editorial costs must be met by some form of subsidy. These editorial costs are more than twice those for printing. Subscribers pay less than one dollar for each two dollars paid from other sources. The income from subscriptions is an important item in itself, but it is doubly important because it is the concrete evidence of the extent to which individual biologists are contributing their share to the undertaking. Nothing is so vital to the obtaining of permanent endowment for the editorial work of the *Abstracts* as a substantial increase in the subscription lists within the next twelve months. There are now three thousand subscribers. There should be five thousand.

Subscriptions are also important at the present time because printing costs must be paid by subscrip-

tions. The 50,000 abstracts in hand editorially for the year 1931 and the indices in arrears can not all be published without more money from this source. Every dollar received from additional subscriptions will count toward current publication as well as in support of the solicitation of permanent endowment for editorial costs.

A campaign of publicity and of advertising for subscriptions is being initiated, but thirty societies in a union present a difficult problem as compared with the situation of the chemists with a single society. The Union of American Biological Societies has undertaken to support this campaign as the most effective means of increasing the subscription list. Thus, editorial costs are paid by subsidy, printing by subscriptions, and selling costs in the present emergency will be paid by the union. The funds of the union are derived from contributions by member societies. These funds must be voted, and most of the societies do not have business or executive committee meetings until next December. Hence we are especially in need of every dollar that can be obtained within the next six months. The original financing of the union came in part by contributions of from one to ten dollars from individual biologists. It is thought that many will wish to contribute in the present emergency. Checks should be sent to A. L. Quaintance, treasurer, Silver Spring, Maryland. The officers of the union also urge every biologist to use his best efforts in securing additional individual subscriptions at $9.00 and institutional subscriptions at $15.00.

W. C. CURTIS
F. E. DENNY
A. L. QUAINTANCE
I. W. BAILEY
C. W. GREENE
A. F. WOODS
Executive Committee, Union of American Biological Societies

REPORTS

COMMITTEE ON EFFECTS OF RADIATION UPON ORGANISMS OF THE NATIONAL RESEARCH COUNCIL

THE organization and initial activities of this committee were reported in SCIENCE, January 4, 1929. A statement of its policies and of assistance rendered to investigators during the first two fiscal years of its existence, 1929–30 and 1930–31, may now be recorded.

The general policies announced in the report above cited have been in practice with modification of details as experience has shown desirable. The funds are handled by the methods current with the Research Council. Investigators have been informed and applications invited by periodic advertisement in SCIENCE, as with the National Research Council Fellowships and by other justifiable publicity. Reports of progress and copies of published papers are submitted annually for current information of the committee by each investigator assisted. On March 1, 1931, there were 27 titles thus recorded.

Although dealing with the effects of physical agencies, the committee has been composed of individuals who are primarily biologists. The advice of physicists has been sought informally as seemed desirable. For purposes of cooperation, the addition of a physicist recommended by the Division of Physical Sciences of the Research Council has been arranged. By this means we shall obtain advice that is often needed and also cordial support from another division of the council.

Donations of money totalling $25,000 per year by the Commonwealth Fund and the General Education Board and gifts of money and apparatus were mentioned in the earlier statement. Experience shows that for legal and practical reasons large sums of money can not be expected from manufacturing organizations for work of this character. The current industrial depression is also a deterrent factor. Nevertheless, the committee has received $6,300 from this source. It is another matter with apparatus. This has been freely donated, and there is a list of over twenty-five cooperating industrial organizations. These contributions of apparatus are received in various ways now that the system is well in action. Under one arrangement the donation is outright and title to the apparatus rests with the Research Council. Assignment is made year by year with the expectation that title will ultimately be transferred to some institution where the use will be permanent and effective. In other cases the manufacturers loan directly to the investigator upon recommendation of the committee for as long a period as may be required. This method is simpler in administration since it does not involve the Research Council in matters of title and consequent responsibility. Or the manufacturer may donate to the institution in which the investigator is located. In practice it has been found impossible to keep an exact account of the apparatus made available under these diverse conditions, but it represents a large sum and there is reason to believe that support of this nature will be forthcoming throughout the period of the committee's activities. In addition to assignment of apparatus there is often opportunity to introduce investigators to the research laboratories

of industrial establishments from which advice and other assistance may be given.

The efforts of the committee with regard to apparatus are being directed not only toward the furnishing of needed equipment to the individual, but toward its more economical and effective use. Biologists often encounter difficulties in the operation of complicated physical instruments. These should really be in the hands of physicists and technically trained physical rather than biological assistants. The x-ray apparatus at the Marine Biological Laboratory is an example. For several years this was in charge of a biologist who had special qualifications. It was as well managed as could have been expected by one not a physicist, but the operation of such apparatus at the seashore is troublesome and during the summer of 1929 increasing difficulties were encountered. In 1930 it was possible, by a cooperative arrangement, to place the apparatus in charge of Dr. Failla, of the Memorial Hospital in New York City. During June, July and August, Dr. Failla was in residence at Woods Hole as an investigator and as an adviser to those who desired his assistance in the use of radium or x-rays. The arrangement will probably be continued by the committee in 1931.

Assistance in both apparatus and money is given to individuals rather than institutions, but the importance of the Marine Biological Laboratory and the Cold Spring Harbor Biological Laboratory as centers to which investigators are drawn is such that these institutions may be considered apart. With Dr. Fricke at Cold Spring Harbor throughout the year and Dr. Failla at Woods Hole during the summer, many investigators can be served in the manner indicated. The committee has, therefore, felt it desirable to support these two laboratories in every way possible by grants of apparatus and the manufacturers appear to be quite appreciative of the situation.

In considering the relative merits of different investigations it was felt that something like a "survey" of the present status of research upon the effects of radiation upon organisms might be undertaken for the better guidance of our subcommittee on allotment and for information of the standing committee in any solicitation of additional support or other contacts. A subcommittee on survey was accordingly established and brought together in March, 1930, in Washington. As the field is diversified this subcommittee includes the following general interests:

Genetics: A. F. Blakeslee, Carnegie Institution; L. J. Stadler, University of Missouri.

General Physiology: Janet H. Clark, Johns Hopkins University; Max Ellis, University of Missouri; S. O. Mast, Johns Hopkins University.

Development: E. E. Just, Howard University.

Plant Physiology: C. Stuart Gager, Brooklyn Botanic Garden; W. W. Garner, U. S. Department of Agriculture; H. W. Popp, Pennsylvania State College; B. M. Duggar (*chairman*), University of Wisconsin.

On the zoological side this subcommittee divided the field in the manner indicated, and on the botanical side into four divisions for problems especially related to plants. It was thought that the most satisfactory way to begin such discussion would be to bring together as advisers to the subcommittee investigators in the several fields, but to do this at a time when other business was not at hand would be expensive. A meeting of such individuals interested in *development* was held at Woods Hole in August, 1930, without expense. On November 1 and 2, 1930, a meeting for *Genetics* was held in St. Louis, through generosity of the General Electric X-ray Corporation. With a few exceptions this meeting, which lasted a full two days, was attended by all the leading investigators in this country now interested in the effects of radiation upon heredity. Although the meeting resolved itself into accounts of each man's work, followed by informal discussion, and was seemingly more profitable to the individuals concerned than to the committee, there has resulted a clarification with reference to future distribution of support and there seems no question of the stimulus to the participants, since they exchanged ideas in a way that is never possible at the annual meetings of a scientific society.

For *General Physiology* a meeting was held in Washington on November 8. In this case the financing was provided by joint contributions from the General Electric, Cooper-Hewitt, Westinghouse and Burdick Companies. It was attended by about thirty individuals, including representatives of clinical medicine and of the manufacturers. Here again individuals discussed their work, although in more general terms than the geneticists. The effects of x-rays and radium and of ultra-violet light were especially considered. The latter problem is of great interest to manufacturers at the present time because there is no adequate evidence from animal experimentation to support the belief of many clinicians in the efficacy of ultra-violet in general therapy, although in the specific instance of rickets these rays are unquestionably effective. If it can be shown beyond question that ultra-violet thus affects the general health and resistance of human beings, there are great possibilities for its commercial exploitation in artificial illumination. Some of those present, whose competence could not be questioned, felt obliged at this meeting to tell our friends among the manufacturers that the experimental evidence on animals is still inconclusive, save in the case of rickets, and that clin-

ical interpretations of results on human beings are open to serious criticism. But there remains a residue of clinical observations that justify further study, alike for their scientific importance and for their commercial possibilities. The fact that so wide a range of wave-lengths have been involved in most research upon effects of ultra-violet light may account for conflicting observations, if it can be shown that some wave-lengths in this series are beneficial to man and the higher animals while other lengths are ineffective.

For *Plant Physiology,* meetings were made possible in Washington on March 14 and 15, 1930, by the committee on grants-in-aid of the Research Council, with an attendance of about twenty-five individuals. The results of the discussions in all these gatherings will be assembled for the confidential use of the committee on radiation and for other purposes, including, no doubt, ultimate publication of certain derivative material of value to investigators.

Grants during the period of January 1, 1929, to June 30, 1931, may be summarized as follows:

Some 32 investigators have been assisted with money and many of these have also received apparatus; 9 have received apparatus only; 4 have been loaned for extended periods the 125 milligrams of radium placed at our disposal by the Radium Chemical Company; 17 of the above 32 investigators received grants for both 1929–30 and 1930–31; 15 received a grant for only the first of these years or for the first time in 1930–31. The total amount of these grants to June 30, 1931, is $53,315.73. The amounts in single grants during the two and one half years since January 1, 1929, include: 1 for $2,100; 8 for $2,000; 4 for $1,800; 1 for $1,750; 1 for $1,170; 1 for $1,600; 1 for $1,500; 1 for $1,250; 2 for $1,200; 4 for $1,000; 2 for $900; 3 for $800; 6 for $750; 5 for $500; 1 for $400; 6 for $300; 1 for $200; 1 for $150; 2 for $100.

In preparing this statement attention has been drawn to the titles listed on the program of the principal organization of American geneticists at the scientific meetings in Cleveland, December 29, 1930, to January 2, 1931. Papers by individuals who have been substantially assisted by the committee constituted a relatively large fraction of this program. In addition to Blakeslee, Muller, Patterson, Stadler, Weinstein and Whiting, there appear the names of several students introduced by these individuals. This may be cited as an example of the wide-spread influence of the committee in one of the principal fields in which it is supporting investigation.

W. C. CURTIS,
Chairman

SOCIETIES AND ACADEMIES

THE IOWA ACADEMY OF SCIENCE

THE forty-fifth annual meeting of the Iowa Academy of Science was held at Davenport, Iowa, at the Davenport Public Museum and Saint Ambrose College on May 1 and 2 with 203 members and visitors in registered attendance.

The president's address, "Some Remarks on Mathematical Statistics," was given by Dr. H. L. Rietz, of the State University of Iowa, after a welcome by Mr. E. K. Putnam, the director of the Davenport Public Museum, and Fr. Martin Cone, president of Saint Ambrose College. The address, presented by the academy to the citizens of Davenport, was made by Dr. M. F. Guyer, chairman of the department of zoology at the University of Wisconsin, on "Internal Secretions and Human Well-being."

A grant from the academy research fund was made to Professor H. E. Jaques to help carry on an entomological survey of the State of Iowa.

The academy approved the organization of a junior academy of science, composed of high-school science clubs, which would be affiliated with the senior academy. A provisional constitution was approved and the furtherance of the movement was placed in the hands of a committee on high-school relations.

Officers and section chairmen for the year 1931–32 were elected as follows:

President, J. E. Lees, Des Moines.
Vice President, H. E. Jaques, Mt. Pleasant.
Treasurer, W. F. Loehwing, Iowa City.
Editor, G. H. Coleman, Iowa City.
Secretary, J. C. Gilman, Ames.
Representative of the American Association for the Advancement of Science, C. W. Lantz, Cedar Falls. The new chairmen of sections are: Botany, G. W. Martin, Iowa City. Chemistry, inorganic and physical, T. H. Liggett, Pella. Chemistry, organic and biological, H. A. Mattill, Iowa City. Geology, E. J. Cable, Cedar Falls. Mathematics, C. W. Strom, Decorah. Physics, T. C. Poulter, Mt. Pleasant. Psychology, T. F. Vance, Ames. Zoology, R. L. Abbott, Cedar Falls.

Botany Section: E. W. Lindstrom. Twelve papers were presented before this section, some of which were of sufficient general importance to merit attention. W. E. Loomis and K. H. Burnett reported on the photosynthetic efficiency of maize, using field plants from which certain parts (leaves or ears) were removed. Soil aeration of experimental plants was found by W. F. Loehwing to exercise a profound effect on root growth and on general plant growth

and maturation. J. M. Aikman discussed the microclimate of maize in relation to other ecological factors in field plants. Tetraploid tomatoes derived from three different genetic sources were shown to possess differential fertility (pollen and seed formation) dependent upon their chromosomal makeup. A true-breeding tetraploid tomato was also reported by E. W. Lindstrom. I. E. Melhus gave a comprehensive résumé of recent advances in corn disease investigations. J. C. Gilman and E. M. Summers reported on the thermogenic capacities of some fungi from heating corn. Three mycological papers, largely of taxonomic interest, were presented by G. W. Martin, Ella Baskerville and Marion C. Fisher. Notes on Iowa mosses by Lucy M. Cavanagh were read. An ecological study of glacial relict plant communities was presented by H. S. Conard. The sessions closed with a round-table discussion on teaching botany, led by S. M. Dietz.

Chemistry, Organic and Biological: L. Chas. Raiford. The program of the section of organic and biological chemistry listed 10 papers, which included the results of researches that have been in progress during the past year in several of the laboratories of schools and colleges in Iowa. The section was in session Friday afternoon and Saturday morning. By vote of the group two papers not listed on the program were presented at the Saturday morning session. The attendance was large and the reports called forth considerable discussion. The chairman selected for the coming year is Professor H. A. Mattill, of the State University of Iowa.

Geology Section: L. W. Wood. The program of the geology section included an unusually large number of papers of general interest to all parts of the state. Two papers by G. F. Kay on classification and duration of the Pleistocene were outstanding in the importance of new material presented in them. Papers by A. C. Tester and N. C. Georgeson dealt with certain phases of the stratigraphy of the Cretaceous System in western Iowa and the adjoining portions of the adjacent states. A paper by Paul T. Miller on the "Iowan Gravels in Northeastern Iowa" was well received and provoked considerable discussion. Mark Morris delivered a paper on "Unsoundness of Certain Types of Rocks," pointing out the importance of this characteristic as affecting their serviceability in structural uses. A. C. Tester presented evidence of a case of contemporaneous deformation in the Cedar Valley Limestone. G. F. Kay gave an explanation of a possible method of formation of the "Peble Band" often found on the surface of the Iowan Till. The final paper was a discussion by James H. Lees of the extremely interesting section obtained in the Clarinda oil prospect drilling. Five other papers were read by title in the absence of their authors. The section meeting was attended by a group of about thirty people.

Mathematics Section: John F. Reilly. The twentieth regular meeting of the Iowa section of the Mathematical Association of America was held in conjunction with the forty-fifth meeting of the Iowa Academy of Science. A program of nineteen papers was presented, a majority of which treated of some phase of theoretical or applied statistics. The retiring chairman, Professor George W. Snedecor, gave an address on "Standard Deviations of Standard Regression Coefficients." Officers for the coming year were elected as follows:

Chairman, Carl W. Strom, Luther College.
Vice Chairman, Byron D. Roberts, Parsons College.
Secretary, John F. Reilly, University of Iowa.

Psychology Section: E. O. Finkenbinder. About 75 workers in psychology discussed 30 studies of exceptional interest to all. Harry A. Green's paper evaluated Iowa University's new technique of recording speech so as to study it objectively. Dean Seashore presented a new scientific musical staff that indicates exactly when a tone is produced, the length of time it is held, its intensity, and its timbre, all mechanically produced. Seven other papers on the psychology of music were presented, among which were: hearing the vocal vibrato, by Harold Seashore; the vibrato of stringed instruments, by Scott Reger; an artistic pianogram, by Miss Laila Skinner; an analysis of intensity in piano playing, by D. A. Rothchild. There were two papers on art and three on attitudes of delinquents as compared with normals. E. O. Finkenbinder showed that twice as much information learned from scored quizzes composed of direct questions was remembered for six weeks as that learned from scored quizzes made up of true and false statements. B. F. Zuehl showed that students prefer objective tests as motivation for their study. F. B. Knight's paper indicated that the position of a given combination of numbers in a problem influenced its difficulty greatly. J. W. Charles pointed out that upper classmen receive the higher marks. E. O. Finkenbinder's tabulation of the amount of absence since the beginning of the century at the State Teachers College showed that the amount of absence was cut from 2.2 per cent. per pupil that existed before the rule was adopted in 1916 that deducts one tenth of a credit for each absence not excused, to 1.2 per cent. after the rule went into effect; and that the percentage of pupils who were in perfect attendance per term was raised from 42 to 69—more than a 50 per cent. gain in regularity due to the rule. E. C. Denny found that the Ayres spelling scale has some words in a column that are much more difficult than others. Miss Gertrude Cox indicated that the Ames psychological tests predict college success.

Clelland Morgan presented two papers on learning, and C. A. Ruckmick gave some recent improvements in galvanic technique.

Zoology Section: H. E. Jaques. The program, while utilizing only one half day, covered a range of interests almost as wide as the zoological field. Two papers were taxonomic, Robert L. King describing new protozoans of the genera *Vorticella* and *Thecacineta,* and Owen Smith illustrating some thirty species of *Tenebrionidae* known to occur in Iowa and providing a key for their identification. Records of golden and bald eagles as well as some other rather unusual birds which have been seen recently in southeastern Iowa were presented by Pete Parks, while F. L. Fitzpatrick showed that raptorial birds rather frequently possess bilateral ovaries. William T. Levine found the ovaries of frog tadpoles to degenerate when treated with x-ray. In a study of the hormone influence on the reproduction functions of parabiotic female rats Robert T. Hill reported the corpus luteum hormone stronger and more positive in action than the oestrous producing hormone, and E. W. Shrigley told of a marked difference in the susceptibility and resistance to anaphylactic shock in guinea-pigs and discussed methods of selecting. H. E. Jaques explained some methods used in conducting field contests to increase student interest in biological subjects, while Elizabeth Blagg displayed an exceptionally large earthworm and aroused a likely discussion as to the size and abundance of these creatures. Much interest was taken in Roy L. Abbott's recital of some almost human-like readjustment made by the golden digger wasp when its established routine was interfered with by the experimenter.

JOSEPH C. GILMAN,
Secretary

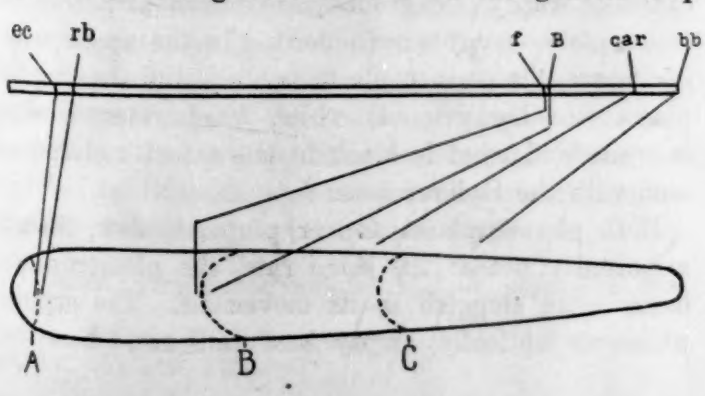
SPECIAL ARTICLES

A CYTOLOGICAL MAP OF THE X-CHROMOSOME OF DROSOPHILA MELANOGASTER

SEVERAL years ago the writer, together with Dr. H. J. Muller, pointed out that as a result of our combined genetic and cytological studies of deletions and translocations in *Drosophila melanogaster* we were forced to the conclusion that the genetic crossover maps do not give a proper concept of the morphological spacing of the genes along the chromosomes. Dobzhansky was led to the same conclusion by evidence similar to ours and his cytological maps of the second and third chromosomes have amply proved the correctness of this point of view.

Since the publication of our original papers, I have been collecting data which would permit me to plot a cytological map of the X chromosome. Dr. H. J. Muller and Dr. J. T. Patterson and their students have placed at my disposal many cases of breaks, translocations and deletions and by a cytological study of these it is now possible to give the approximate location of certain genes.

In the accompanying figure I have indicated the location of the genes involved on the genetic map and below this an outline drawing of a typical X chromosome with lines to show the position morphologically of the points which have been determined.



Beginning with the so-called left hand end of the X chromosome (left in the figure), this winter Patterson obtained a break in the X chromosome between the loci for echinus (5.5) and ruby (7.5) and this segment became attached to one of the fourth chromosomes. (See Patterson and Painter in a recent issue of this journal for genetic and cytological evidence). Morphologically this piece which carries at least 5.5 genetic units (but does not extend to 7.5) is about three times as large as a normal fourth chromosome. The estimated proportional size of this segment is indicated on the schematic X chromosome by the line A, and since echinus is carried by the translocated piece and ruby is not, these two loci must lie to the left and the right of the line A, respectively.

Recently, Mr. Wilson Stone, a student of Dr. Muller, obtained a break in the X chromosome between the loci for forked (56.6) and bar (56.8)—genetic data unpublished—and the segment from the left hand end which must thus carry at least 56.6 genetic units was translocated to a fourth chromosome. This case was studied cytologically in females carrying a normal X and the two pieces of the broken X, and also in females hyperploid for the bar-carrying piece. The piece of the X chromosome which carries bar was found to be about three fourths the size, in length and volume, of the normal X chromosome in the same cell, and the piece which was translocated to the fourth chromosome is about a fourth the volume of the normal X. On the figure the length of the bar segment is indicated by the line B. The locus for

bar must be to the right of this line, and forked as well as the 56.6 genetic units from the left end must lie to the left of the line B.

In one of the first deletions studied genetically by Muller and cytologically by the writer, there were at least 64.5 genetic units missing from the X chromosome [the locus for prune (1) but not white (1.5) was present; the locus for carnation 65.5 was lacking but bobbed (70) was present] and this deleted X was about a third of the normal X chromosome in size. At the time of these earlier studies we did not know what proportion of the deleted X was due to the left and right hand ends respectively, but in view of the recent finding that only the tip of the left hand end is involved morphologically when 5.5 genetic units are missing, it is clear that the size of the deleted X must have been due almost entirely to the right hand end segment. The size of the deleted X is shown on the figure by the line C. Since carnation (65.5) is not present in this deleted X it follows it must lie somewhere to the left of the line C but to the right of the bar locus and that bobbed, which is present, must lie to the right. From the nature of the evidence, we can not locate carnation or bobbed more accurately at present than as indicated above, but in view of the location of ruby and of bar, one might guess that carnation would lie much closer to the bar locus than the line C.

An analysis of other cases, the data for which we can not give in this brief article, fits into the cytological map as here given. Complete cytological evidence and pertinent discussion will be presented in a longer paper now about ready for press.

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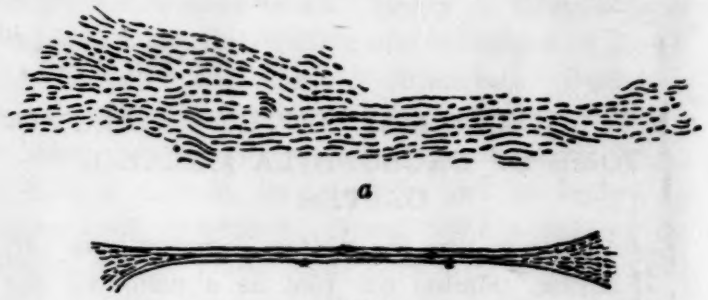
THE STRUCTURE OF PROTOPLASM

INSUFFICIENT optical differentiation between the constituent parts of protoplasm has greatly hampered the advance of knowledge of protoplasmic structure. Dark-field illumination with the cardioid condenser has helped but little. The recent invention of a dark-field oil-immersion objective by Charles Spierer[1] is a very successful forward step in indirect illumination methods, especially when applied to the study of the colloidal structure of living matter. The Spierer lens reveals a structure in living protoplasm, as it does in celloidin[1] and in the cellulose walls of plant cells,[2] which is not visible with any other optical system.

The Spierer lens is a Zeiss 1/12 inch oil-immersion objective with a small platinum mirror electrolytically deposited at the center of the upper surface of the lowermost lens of the objective system. This mirror reflects all direct light, thus producing a dark-field. The scattered (colloidal) light from the object viewed is picked up by the lens around the mirror. Increased detail results because direct light is used instead of the usual bilateral illumination of the older type of ultramicroscope. The optical principles involved and a fuller description of the lens are given in other publications.[1,2]

When the hyaline protoplasm of living onion cells is viewed through the Spierer lens, it is, under favorable conditions, seen to consist of two substances, one brightly illumined, light gray in color, and very finely granular in texture, and the other, an optically empty, black background. In quiescent protoplasm these two substances are intermixed as an emulsion and then present a mottled appearance. Protoplasm under tension, as it is when formed into a thread (Fig. 1, a),



a

b

FIG. 1

or when streaming (Fig. 1, b), assumes a striated appearance, due to the parallel arrangement of long strands of the illuminated substance. These strands may be continuous (Fig. 1, a) or discontinuous (Fig. 1, b); in the latter case they are made up of rods oriented end to end. The striated structure is seen at its best in actively flowing protoplasm. Included particles occur, and appear as brilliant globules imbedded in either the gray matter or the dark intervening substance.

Without any attempt to characterize chemically or vitally the two phases which make up this dark-field structure of protoplasm, I propose calling the brightly illuminated, gray-appearing, and at times discontinuous, dispersed phase, the *phaneroplasm,* (*phaneros* = evident), and the unilluminated, black-appearing, optically empty background, or continuous phase, the *cryptoplasm* (*cryptos* = hidden). In the accompanying figure, the phaneroplasm is black and the cryptoplasm (the background) white, which reverses what is white and what is black in the actual material as seen with the Spierer lens.

Both phaneroplasm and cryptoplasm flow, though apparently not at the same rate, the phaneroplasm being more sluggish in its movement. The cryptoplasm is optically empty and can not, therefore,

[1] "Un Nouvel Ultra-microscope à Éclairage Bilatéral," *Arch. Sci. Phys. et Natur.* (Genève) 8: 121, 1926.

[2] "The Spierer Lens and What it Reveals in Cellulose and Protoplasm," *Jour. Phys. Chem.* 118: 35, 1931.

actually be seen; its streaming is, however, made evident by the movement of included particles. A rapidly moving particle may, where there is an irregularity in the arrangement of the striae, strike against the side of a strip of phaneroplasm; its forward movement is thus retarded, but only for a few moments while it is slowly pushed through the phaneroplasm, first thinning it, and then breaking through. This and other similar events indicate that *the cryptoplasm is the actively streaming component of protoplasm.*

The strands of phaneroplasm are from 0.3 to 0.4 μ in thickness and 0.2 to 0.3 μ apart.

Except for the optical properties already referred to, there is little to be said concerning the physical, chemical and vital nature of the two substances which make up the living hyaline diphasic system. The phaneroplasm is brightly illuminated but the cryptoplasm is not. Where the protoplasm, at rest, assumes a mottled appearance, the phaneroplasm becomes the dispersed phase and the cryptoplasm the dispersion medium of an emulsion; where the protoplasm is striated but the striae broken, the structure is still that of a (distorted) emulsion; but where continuous striae exist, there is no distinction between a discontinuous and a continuous phase, that is to say, there is no emulsion as ordinarily defined.

New terms are convenient if merely as temporary handles to be discarded as knowledge of the subject increases, but they add confusion if satisfactory old terms exist. Strasberger[3] distinguished between kinoplasm (active substance) and trophoplasm (nutritive substance), two terms which have been brought into use again by Lloyd and Scarth;[4] but these terms are not applicable to the cryptoplasm and phaneroplasm described here if Strasberger's original description is to be adhered to. He says that kinoplasm possesses a fibrous structure and trophoplasm the structure of a honey-comb, and that the two substances may be in quite distinct regions of the cell. No such differences are evident in the dark-field structure of protoplasm as seen by the Spierer lens. This lens differentiates not kinoplasm from trophoplasm, but two substances which make up the kinoplasm alone.

There does not appear to be any satisfactory correlation between the structure of actively flowing hyaline protoplasm as revealed by the Spierer lens, and structures seen and described before. The mottled emulsion structure of the resting protoplasm is, in a broad way, comparable to alveolar protoplasm as described by Bütschli, and to numerous other pseudo-alveolar, vacuolate and emulsion structures. The striated structure of protoplasm when under tension, has apparently no counterpart in the older literature.

The nearer we approach the ultimate structure of protoplasm the less easy it is to differentiate between the relative importance of its constituents, but the idea that some substances in living matter are more important than others is often entertained. If we attempt to draw a distinction between the relative "vital" significance of phaneroplasm and cryptoplasm, then, frequent discontinuity in the former and active streaming of the latter suggest that cryptoplasm is the more fundamental of the two.

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[3] "Ueber Cytoplasmastructuren," *Jour. wiss. Bot.* 30: 375, 1897.

[4] "The Rôle of Kinoplasm in the Genesis of Vacuoles," SCIENCE, 65: 599, 1927.

ON A POSSIBLE EFFECT OF FUNGICIDES UPON THE COMPOSITION OF APPLES

THERE is prevalent among the practical fruit-growers of the Annapolis Valley district of Nova Scotia the opinion that apples sprayed with sulphur fungicides do not keep as well in common storage as those sprayed with copper fungicides. Actual storage comparisons have not, however, indicated any marked difference in the rate of senescence of fruit treated with these respective fungicides as evidenced by the rate of fall of the pressure test, by the appearance of the fruit, or by its rate of spoilage. One of the workers, at present actively engaged in making storage tests of this nature, has, nevertheless, found differences in flavor sufficiently marked to enable him to differentiate (by blindfold test) unsprayed fruit from that which has been treated during the growing season with sulphur or with copper fungicides. This fact indicates that there may actually be a difference in composition induced by the repeated use of these respective fungicides during the growth period of the fruit.

In an attempt to obtain evidence of such differences the authors have recently made analyses of apples of the Northern Spy and Ribston Pippin varieties which had received various fungicidal treatments. Samples of five apples each of the former variety and of ten apples each in the case of the latter were selected from quantities of fruit gathered in connection with a study (in progress) of the amounts of sulphur and copper remaining upon the fruit at harvest under Nova Scotian conditions. This fruit had received uniform storage treatment of the common storage type since date of picking, and all samples were gathered at practically the same stage of maturity. The apples were quartered, the stems and cores removed, and the remaining tissues finely ground in a common food chopper. Samples of 25 grams each were weighed out as soon as possible after thorough mixing of the

mass of pulped tissue, and killed by dropping into sufficient boiling 95 per cent. alcohol to make the final alcohol concentration about 80 per cent. The sucrose equivalent of the total reducing power of the alcoholic extract, and of the extract obtained by hydrolyzing the alcohol-insoluble residue for one and one-half hours with a 3.6 per cent. solution of hydrochloric acid, were determined by the cuprous chloride-iodine method.[1] Aliquots of the alcoholic extract were also titrated for acidity. The variations in acidity were, however, small and showed no definite trend. In the case of the reducing power of the alcoholic extract, and also that of the alcohol-insoluble residue after hydrolysis, there was an indication that the fruit which had been treated with sulphur fungicides during the growing season possessed, at the time of the analysis (December 19, 1930, and January 3, 1931), a slightly lower reducing power than unsprayed fruit or fruit which had been sprayed with Bordeaux mixture. Particularly was this true when the sulphur treatments were considered as a group and compared with the check and copper treatments as a second group. The actual results are given in the accompanying table, where the values marked with an asterisk indicate the average result obtained for three samples, the others the average for duplicate samples.

Variety	Treatment	Sucrose equivalent		
		Alcoholic extract	Alcohol-insoluble-acid-hydrolyzable	Total
Northern Spy	Lime-sulphur	10.61*	1.11*	11.72*
" "	Lime-sulphur with ferrous sulphate	10.84	1.13	11.97
" "	Unsprayed	11.06*	1.16*	12.22*
" "	Bordeaux	11.24*	1.17*	12.41*
Ribston Pippin	Sulphur dust	10.90	1.25	12.15
" "	Lime-sulphur with aluminium sulphate	10.98	1.31	12.29
" "	Bordeaux	11.40	1.41	12.81
" "	Unsprayed	11.60	1.43	13.03
" "	Lime-sulphur	11.76	1.37	13.13
Average of all	sulphur treatments	11.02	1.23	12.25
" " "	other treatments	11.33	1.29	12.62

These results can not be considered as demonstrative of an actual difference in the composition of apples resulting from varying fungicidal treatment, the number of determinations being too few and the differences too small. They may perhaps be taken as indicating that further investigation of the problem is justified, and it is the intention of the authors to make a more detailed study as soon as time and opportunity permit.

W. A. DELONG
A. D. PICKETT

DIFFERENTIATION OF VIRUSES CAUSING GREEN AND YELLOW MOSAICS OF WHEAT

IN previous papers[1,4] dealing with the wheat mosaic occurring in Illinois and Indiana, attention was called to severe yellow mottling, streaking or striping phases associated with dark green and light green mottled phases. Similar associations have been observed in natural field infections in Virginia and in North Carolina. It has been pointed out[1,4] that the Currell variety, selections of several other wheat varieties and Red Winter spelt develop yellow mosaic to some extent in the spring when the seed is planted out of doors in virus-infested soil in the autumn, whereas certain other varieties of wheat (Harvest Queen) when grown simultaneously in the same soil and in adjacent rows develop green mosaic, become dwarfed, producing a condition which has been termed rosette, and show only occasional traces of yellow mottling, striping or streaking.

Although these several expressions of the disease are influenced by the species and variety of the host plant, it has been considered[4] that a mixture of virus might be present in the soils under study and that the several types of hosts may differ in their susceptibility to distinct viruses.

To obtain information on this phase five successive series of inoculations were made. Except for slight modifications the procedure was that used in building up severe yellow mosaics on tobacco, tomato and *Nicotiana glauca*[2,3] (pp. 562–563). In the case of solanaceous species it is possible to cut the small yellow mosaic areas from the green mosaic regions and obtain sufficient virus for the inoculation of a large number of plants. Owing to the small size of wheat leaves and the difficulty of obtaining sufficient virus from the narrow yellow spots or streaks initial virus

[1] F. M. Scales, "The Cuprous Chloride-Iodine Method for Sugars Simplified," *Jour. Ind. Eng. Chem.*, 11: 747, 1919.

[1] H. H. McKinney, "A Mosaic Disease of Winter Wheat and Winter Rye," U. S. Dept. Agr. *Bul.*, 1361, 1925.

[2] H. H. McKinney, "Virus Mixtures that May not be Detected in Young Tobacco Plants," *Phytopathology*, 16: 893, 1926.

[3] H. H. McKinney, "Mosaic Diseases in the Canary Islands, West Africa, and Gibraltar," *Jour. Agr. Res.*, 39: 557–578, 1929.

[4] H. H. McKinney, "A Mosaic of Wheat Transmissible to All Cereal Species in the Tribe Hordeae," *Jour. Agr. Res.*, 40: 547–556, 1930.

extracts were obtained, the yellow from a Red Winter spelt plant with medium yellow mosaic and the green from a Harvest Queen wheat plant with green mosaic. Both of these plants contracted mosaic from virus-infested soil transported to Arlington Farm, Rosslyn, Virginia, from the infested area near Granite City, Illinois. The virus extracts were obtained in the spring from whole leaves and sheaths or from portions of leaves showing the most intense green symptoms and from leaves showing the most intense yellow symptoms.

Healthy seedlings of Harvest Queen wheat and Red Winter spelt were inoculated with virus extract from the spelt plant with medium yellow mosaic. At the same time healthy wheat and spelt plants of the same varieties and ages were inoculated with extract from the wheat plant having green mosaic. This plant contracted the disease late and showed no rosette symptoms.

All inoculations were made according to the method described previously.[1] The plants were given eight hours daylight daily, and soil and air temperatures were held near 60° F. except during midday in sunny weather when the temperature usually went above 60° F.

Mosaic symptoms appeared in from two to ten weeks after inoculation, four to five weeks being the time required by the majority of the plants.

The results of the test on Harvest Queen wheat showed that yellow mosaic predominated in the plants inoculated with virus from yellow mosaic, and green mosaic predominated in those inoculated with virus from green mosaic. However, most of the plants showed some signs of both types, and typical rosette developed in most of the plants in both inoculations.

All Red Winter spelt plants produced yellow mosaic, but the yellow was more intense in the plants inoculated with virus from the plant with yellow mosaic. This variety of spelt never develops the rosette symptom.

Following the first test four additional successive tests have been carried out. In all these the yellow mosaic and the green mosaic viruses were obtained respectively from plants with the most pronounced yellow mosaic and the most pronounced green mosaic in the previous tests. As the work has progressed the green mosaic consistently has become more green and the yellow mosaic consistently more yellow.

In all tests after the first no rosette occurred in Harvest Queen inoculated with the virus of yellow mosaic, and in all tests after the second typical rosette occurred in all Harvest Queen plants inoculated with the virus of green mosaic.

In the fifth test only Harvest Queen plants were inoculated. Those inoculated with virus from yellow mosaic developed the most severe symptoms yet encountered in wheat mosaic. Soon after the first signs of the disease appeared many of the leaves became almost entirely yellow and these died quickly. Many plants died rather early. However, as the surviving plants continued slow growth the disease frequently became less severe. In these particulars the plants behaved like young tobacco and tomato plants inoculated with virus from the most severe forms of yellow mosaic originating from the common mosaic of tobacco[3] (p. 563).

The green and the yellow mosaics of the small grains do not always develop on all the tillers of a given plant and in certain varieties it appears that complete recovery from the disease occurs in some plants.

In the fourth and fifth tests the green mosaic symptoms were very mild in many of the plants, but the rosette symptoms were very typical.

It is clear from these experiments that the wheat mosaic under study represents a mixture of types which can be resolved into distinct yellow and green forms. This mixture occurs in both the yellow and the green types occurring in nature. The yellow type has been concentrated in relation to the green type and has been rendered very severe in its expression on a variety of wheat (Harvest Queen) which shows only slight traces of it in combination with green mosaic when infections occur naturally from infested soil or when artificial inoculations are made with virus from plants which became infected by way of the soil.

It is evident also that rosette is not associated with yellow mosaic on Harvest Queen wheat, whereas it is associated with green mosaic on this variety. The nature of the association between rosette and green mosaic must be studied farther. A single virus may cause both expressions or more than one virus may be involved.

A very faint trace of yellow mosaic still appears in a few Harvest Queen plants having the purified green mosaic. On spelt this yellow mixture is more evident, and on this account attempts to completely remove the yellow trace are being continued with spelt. However, it is possible that all traces of the yellow form can not be removed by existing methods as has been the case up to the present time with the common mosaic of tobacco.[5] Whether a trace of green mosaic is still associated with the purified yellow type on wheat can not be determined so readily.

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[5] H. H. McKinney, "Further Studies on Virus Purification," (Abs.) *Phytopathology*, 21: 118, 1931.

DISSOLVED PHOSPHORUS AND INORGANIC NITROGEN IN THE WATER OF THE MISSISSIPPI RIVER

IN 1921 McHargue and Peter[2] published some results of quantitative studies of the mineral plant-food in natural waters. In their studies were included samples of water from the Mississippi River at Minneapolis, Minn., and Baton Rouge, Louisiana. These authors found that the phosphorus expressed as P_2O_5 at these two stations amounted to 0.25 and 0.15 ppm respectively. From the method employed by them it appears that they determined the total phosphorus in the filtered water rather than the soluble phosphorus only. According to these authors nitrate nitrogen was absent from the Minneapolis sample but occurred in the Baton Rouge sample to the extent of 0.8 ppm. Ammonia nitrogen was apparently not determined in the Minneapolis samples; in the Baton Rouge sample it was present in small quantities.

The present writer has for some time been interested in determining what inorganic constituent of pond water may be the factor that limits plankton production and hence fish production. A rather extensive series of determinations of the principal forms of inorganic nitrogen, and of the soluble and the total phosphorus has been made on the pond waters at Fairport, Iowa.[3] The results of these studies point towards the soluble phosphorus as the limiting factor. Nitrogen as free ammonia and as nitrates was always present but there were times when the soluble phosphorus was completely exhausted. Since these ponds are supplied with water from the Mississippi River, it seemed of interest to determine the variations in these constituents of the river water. These determinations have not been made as regularly as may be desired, but still they give some idea of the amount of free ammonia, nitrates, organic nitrogen, and soluble phosphorus present in the water of the Mississippi River.

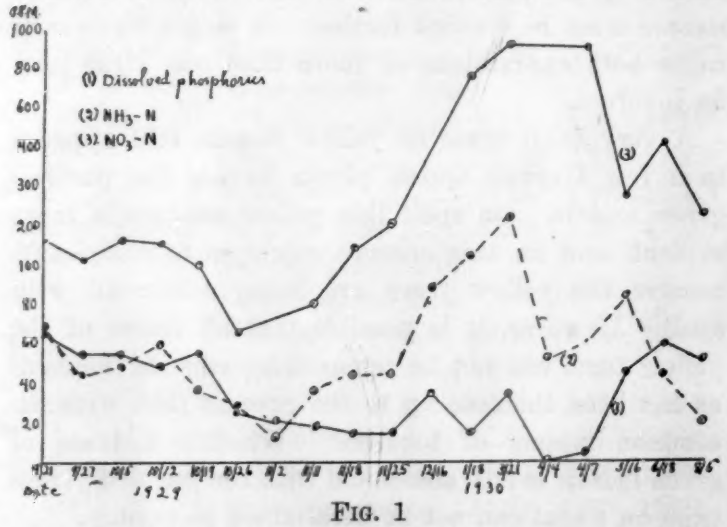

FIG. 1

The variations in the soluble phosphorus, nitrate nitrogen, and ammonia nitrogen for 1929–30 are presented graphically in Fig. 1 expressed in milligram per m^3. Only the soluble phosphorus by Denige's method is shown in the graph. The total phosphorus was not regularly determined but 15 determinations on unfiltered surface samples gave an average of 0.136 ppm; 8 bottom samples gave an average of 0.173 ppm.

The soluble phosphorus varied considerably. The maximum for the surface samples occurred on Sept. 21, 1929, and amounted to .065 ppm; the maximum for the bottom samples occurred on June 18, 1930, and amounted to 0.082 ppm. The minimum for both top and bottom samples occurred on April 4, 1930. At this time the soluble phosphorus had been reduced to a trace. These minimum values occurred simultaneously with an enormous increase in the phytoplankton. This again points toward the conclusion that the soluble phosphorus may at times be a limiting factor. The range of the ammonia nitrogen in the surface samples is from a minimum of 0.012 ppm to a maximum of 0.224 ppm. In the bottom samples this form of nitrogen varies from a minimum of 0.020 ppm to a maximum of 0.184 ppm. Nitrate nitrogen in surface samples ranged from 0.051 ppm to 0.914 ppm and in the bottom samples from 0.060 ppm to 0.776 ppm.

On the basis of an analysis of 44 samples of water it is concluded:

(1) Inorganic nitrogen is apparently not a limiting factor in the waters of the Mississippi River at Fairport, Iowa.

(2) Soluble phosphorus may at times become a limiting factor.

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1 Published with permission of the U. S. Commissioner of Fisheries.

2 J. S. McHargue and A. M. Peter, "The Removal of Mineral Plant-Food by Natural Drainage Water." Ky. Agri Ex. Sta., *Bull.* No. 237.

3 A. H. Wiebe, "Investigations on Plankton Production in Fish Ponds." U. S. Bureau of Fisheries, *Doc.* 1082.

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